MANUAL

of

HUMAN DISSECTION

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Illustrated with original drawings
by the author

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Preface

The following laboratory guide to the dissection of the human body is presented in the hope that it may be found useful by those who, like the author, have come to feel that, with the serious decrease in the number of hours allotted to the subject of gross anatomy in American medical schools of recent years, the admirable but lengthy guides at present available are not entirely satisfactory. With a subject of such tremendous scope, the average freshman medical student can not hope, nor should he be expected by his instructor, to emerge at the end of the severely limited time allowed him with a complete practical knowledge of all phases of structure of the human body. The aim of the present work is to point out to the inexperienced dissector what structures he can reasonably be expected to see in the time at his disposal, and to give directions, with as little excess verbiage as possible, for the procedures which should be followed in the demonstration of these structures. The book is designed essentially for use in the dissecting room; the descriptive matter it contains is intended to accompany the actual inspection of the dissected parts. It makes no pretense of being a complete text-book of descriptive anatomy. The knowledge gained in the dissecting room from the body, with the aid of the dissecting manual, should be supplemented by constant reference to one of the standard descriptive texts.

The author does not claim for the illustrations any high degree of artistic excellence. It has been his aim rather to provide drawings which are accurate, and which may be of practical use to the student. With the exception of a few purely diagrammatic figures, the drawings were all made directly from dissections, and from dissections done in exactly the manner that the student is directed to follow. It is, therefore, thought that they may be of immediate aid to the dissector while at work, and of further use in providing him with a permanent record of the dissection which himself has done. There is the added hope that the simple technique employed may inspire the ambitious student to make similar drawings from his own dissection.

The order of dissection followed may be changed to suit the individual desires of the instructor. The present order is that which the author has found, after considerable experimentation, most favorable for the complete dissection of a single body by one student or one group of students. If it is desired to have two students, or two pairs of students working on different parts of the same body at one time,-the manual will be found to lend itself to a division of the body into two parts, with the diaphragm as the dividing structure.

It may be objected that certain structures, notably the lymphatic system and many of the articulations, have been grossly neglected. The author can only reply that this has been purposely done. The average medical student has neither the time nor the skill properly to demonstrate these structures in his own dissection. The knowledge of these parts which is essential for his further progress is best supplied by lectures, reading, and demonstrations provided by the instructor.

The author is particularly grateful to the publishers for their interest and cooperation at all times, and for their almost saintly patience with his own procrastinations. A special debt is owed to Mr. W. T. Shoener, who personally did the lettering on all of the figures.

Edwin M. Shearer.

Introduction

The right to dissect the human body has been won with difficulty after centuries of struggle against the prejudice of the unenlightened. The callow medical student of the present day, who occasionally finds it amusing to drop a bit of human liver down his partner's neck, is apt to forget that in having at his disposal, without effort on his own part, a well-preserved body for dissection, he is enjoying a privilege for which the anatomist of three hundred years ago would have given much. The body which awaits attention on the dissecting table is all the corporeal remains of what was once a human being, and should be regarded with whatever respect may be evoked by that reflection.

The older anatomist was frequently confronted with the necessity of secrecy and stealth, if he was so fortunate as to procure a body at all, and in addition to this, his work had to be done hurriedly because of the rapidity of decay. With modern methods of embalming and preservation, decay has ceased to be a factor, and the only responsibility of the dissector for the preservation of the body in the dissecting room is to see that it does not become too dry. To avoid drying, the body should always be kept wrapped in damp cloths when not in use. The liberal use of water on the part actually undergoing dissection will help to keep the part from drying, and will also facilitate the process of dissection.

The technique of human dissection is something that can be acquired only by practise. Fortunately, however, an adequate technique is usually acquired with relatively little practise. It differs from the technique of dissection with which the student may already be familiar from studies of comparative anatomy, chiefly because of the vastly larger size of the body. For this reason it is less difficult than the technique of the comparative anatomist, often requiring patience rather than great skill.

The essential instruments for the dissection of the human body are a strong pair of blunt-pointed forceps and a sharp scalpel with a broad blade of medium to large size. Since proper results can not be achieved with a

dull scalpel, a stone for renewing the edge should be always at hand. A blow-pipe, a flexible probe, a pair of scissors of medium size with one rounded and one pointed end, are occasionally needed. Small sharp-pointed forceps, narrow-bladed, sharp-pointed knives, and the various elaborate surgical instruments with which the amateur anatomist so frequently likes to decorate his kit, are quite useless in the dissecting room.

The method followed in dissecting the body is the regional method, in which the design is to see everything that is to be seen in a single region of the body at one time, as opposed to the systematic method more commonly followed in studies of comparative anatomy. In approaching any region of the body, the first procedure is the reflection of the skin which covers it. Skin should be reflected from a region only when that region is to be studied, as skin is the best protection against drying of the underlying parts. The actual technique of skin reflection is best learned by practise, but it is well to remember that the incisions which mark out a flap of skin for reflection must be made completely through the skin, and along their entire length, before reflection is begun, and that the skin must always be reflected cleanly from the underlying fascia. Whenever possible, it is advisable to leave a skin flap attached along one of its borders, so that it may be folded back over the part when this is not in use.

The structures which it is desired to expose and study after the skin is reflected are embedded in the various types of connective tissue which come under the generic term of *fascia*. The further dissection of the body consists, to a very great extent, in the removal of this fascia without injury to the structures it contains. This removal of fascia is known as the *cleaning* of the embedded muscles, nerves, arteries, etc. It is a tedious business, and the dissector will often be tempted to leave it incomplete and pass on to other things when he has cleaned the particular muscle or nerve he is seeking, sufficiently to see that it actually exists. This, however, is a bad practise, not only because careless work is, in itself, detrimental to proper observation, but also because it is cumulative in its effect on the dissection as a whole. The more thoroughly a particular region is cleaned, the more easily and satisfactorily can ensuing and deeper regions be cleaned and observed.

When all of the structures in a particular region have been cleaned, time should be taken for review and study of these structures as they appear

in the body. Too often there is a tendency on the part of the dissector merely to go through the motions of dissection in the dissecting room, and do his actual anatomical study elsewhere, from text-books. The purpose of dissection is not, however, to provide a mild gymnastic exercise, but to afford the opportunity of observation and study of the actual structure of the body itself.

An occasional source of pardonable distress to the inexperienced dissector is the reflection that from a regional study, he is expected to acquire a systematic knowledge of human anatomy. The only consolation that can be offered is that here is an opportunity for exercise of the mild integrative intellectual powers that one who embarks on the study of anatomy may be assumed to possess. Though it is a practical necessity to prosecute the dissection as a series of separate regions, it is by no means a necessity to keep the observations so made in separate regional compartments of the mind. As the dissection proceeds, the knowledge acquired region by region, should be associated in the mind of the dissector so that he will eventually see the body as a whole, and be able to reproduce his knowledge in systematic form, even though, for example, he may never actually have seen the entire arterial system, or the entire nervous system, at one time.

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THE PECTORAL REGION

Before starting the dissection of the pectoral region, identify the bony points which may be felt through the skin. In the midline at the base of the neck is the jugular notch, which marks the superior border of the manubrium sterni. At each side of the jugular notch the prominent medial end of the clavicle may be felt; it takes part in the sterno-clavicular articulation. The clavicle may be felt along its entire length. At its lateral end it articulates with the acromion process of the scapula, which also is subcutaneous, and which forms the bony prominence of the shoulder. The sternum may be felt through the skin in the midline along the entire length of the manubrium and corpus sterni. At the lower end of the corpus sterni is a depression in the anterior body wall corresponding to the xiphoid process of the sternum. About an inch and a half below the jugular notch is a marked transverse bony ridge. This is the sternal angle, which marks the junction of the manubrium and corpus sterni; it is of importance in that it indicates the level at which the second rib joins the sternum, and may be used as a starting point for counting the ribs on the surface of the body.

Observe the position of the nipple. It usually corresponds to the fourth intercostal space, about four inches from the sternum. In the female it is at the summit of a rounded elevation formed by the superficial fascia which contains the mammary gland.

Abduct the arms and observe the axillary folds. These are folds of skin, fascia, and muscle which bound the axilla or arm-pit. The anterior fold is caused by the lower border of the pectoralis major muscle. The posterior fold, which extends farther inferiorly, is caused principally by the latissimus dorsi. Between the two folds the skin, here covered with hair, is indented to form the arched floor of the axilla.

For the dissection of the pectoral region and the axilla the arms should be fully abducted and tied in this position to a long board placed under the shoulders and extending outward on each side. With the body so placed

the following skin incisions should be made: (1) in the midline from the jugular notch to the middle of the xiphoid process; (2) from the upper end of incision one laterally on each side along the full length of the clavicle to the tip of the acromion; (3) from the lower end of incision one laterally and somewhat inferiorly across the thoracic wall to the mid-axillary line; (4) from the lower end of incision one upward and laterally to the nipple, which it should encircle, then upward and laterally along the line of the anterior axillary fold to the front of the arm, and transversely across the front of the arm for about two inches. The two large flaps of skin thus marked out on each side should be reflected laterally. Some difficulty may be met in reflecting the skin of the axilla, since this skin, which is quite thin, is rather firmly attached to strands of the axillary fascia.

When the skin flaps are reflected, the superficial fascia (panniculus adiposus) of the pectoral region is exposed. In the male subject the superficial fascia of this region has no specific characteristics, except that in its uppermost part will be found the fibres of origin of the platysma, a superficial muscle of the neck. In the female, however, it contains the mammary gland, which should now be studied.

The mammary gland does not have a distinct capsule of connective tissue. Its essential glandular portion, the corpus mammae, is embedded in the general subcutaneous fatty tissue, which is here increased in amount. *The corpus mammae consists of from fifteen to twenty lobes, each of which* has a single excretory duct opening separately into a depression on the nipple. Pass a bristle into one of these openings and attempt by dissection to demonstrate the lactiferous duct whose termination it is. Look also for the sinus lactiferus, a dilation of the lactiferous duct just internal to its opening. Internal to the sinus each duct breaks up into smaller and smaller branches within the substance of the gland. These cannot ordinarily be demonstrated in gross dissection.

The pectoralis major muscle should now be cleaned. This is done by removing, in a single layer, the superficial fascia (including the mammary gland and nipple) and the deep fascia covering the muscle. Cut through the fascia (until the red muscle fibres are exposed) in a transverse line running from the lower border of the medial end of the clavicle outward to the anterior aspect of the arm, and in a vertical line along the lateral part of the anterior aspect of the sternum. This will mark out a triangular

flap of fascia which can then be reflected laterally and downward to expose the sternocostal portion of the muscle. In cutting the strands of fascia from the surface of the muscle the blade of the scalpel should be moved in the direction in which the muscle fibres run. When the lower border of the muscle, corresponding to the anterior axillary fold, is reached, the flap of fascia removed from its surface may be cut away and discarded. Next remove the fascia from the upper or clavicular portion of the muscle in the same manner by reflecting it upward and laterally.

The pectoralis major is a large triangular muscle consisting of a smaller clavicular portion and a larger, inferior sternocostal portion, the two usually separated by a distinct groove. The clavicular portion arises from the anterior surface of the medial half of the clavicle. The superficial fibres of the sternocostal portion arise from the lateral part of the entire length of the anterior surface of the manubrium and corpus sterni. Its deeper fibres arise from the anterior surfaces of the second to sixth costal cartilages, but this can not be demonstrated until the muscle is reflected. Laterally the fibres of both parts converge to be inserted together into the outer lip of the intertubercular sulcus of the humerus. The insertion, however, can not be properly studied until the arm is dissected, as it is now under cover of the deltoid muscle.

Attempt to demonstrate some of the small anterior cutaneous nerves which pierce the pectoralis major in longitudinal series slightly lateral to the sternum. These are the terminal portions of the upper intercostal nerves, and supply the skin over the anterior part of the chest.

Identify and clean the cephalic vein. This is a superficial vein of the arm, usually large, but sometimes reduced in size or lacking, which will be found in the present area of dissection in the groove between the upper border of the pectoralis major and the deltoid. It disappears from view by going behind the clavicle in the delto-pectoral triangle. This is a small triangular depression bounded by the anterior border of the deltoid, the upper border of the pectoralis major, and the lower border of the middle portion of the clavicle. Remove the fat which it contains and look for the small delto-pectoral lymph-glands which are often present. Emerging through the fat of the delto-pectoral triangle will also be found the deltoid branch of the thoraco-acromial artery, which accompanies the cephalic vein laterally and supplies the anterior border of the deltoid.

The anterior wall of the axilla is formed principally by the pectoralis major. To prepare the axilla for dissection this muscle should now be reflected. Detach the clavicular portion from its origin, and cut through the sternocostal portion by an incision running parallel and about an inch lateral to its medial border. The detached lateral segment of the muscle can then be turned laterally toward its insertion. As this is done the subjacent pectoralis minor muscle will be exposed and the nerves and vessels which supply the pectoralis major will be seen entering its deep surface. The nerves and arteries should be cleaned. The nerves are branches of the medial and lateral anterior thoracic nerves. These nerves are derived in the axilla from the brachial plexus, to which origin they will later be traced. The lateral anterior thoracic nerve reaches the deep surface of the pectoralis major by winding around the medial border of the pectoralis minor. The medial anterior thoracic nerve usually pierces the pectoralis minor, but may appear at its lateral border. The arteries entering the deep surface of the pectoralis major are the pectoral branches of the thoracoacromial artery; they also appear at the medial border of the pectoralis minor. The pectoralis major can not usually be properly reflected without cutting these vessels and nerves; sufficiently long pieces of them should be retained, however, so that they can be identified later and traced to their origins. (Fig. 1.)

Clean and study the pectoralis minor. It arises from the anterior surfaces of the second to fifth ribs near their cartilages; the fibres run upward and converge to a tendinous insertion on the coracoid process of the scapula.

Observe the costocoracoid membrane. This is a sheet of fascia which occupies the triangular gap between the medial border of the pectoralis minor, the lower border of the clavicle, and the anterior thoracic wall. It is pierced by the cephalic vein, the lateral anterior thoracic nerve, and the deltoid and pectoral branches of the thoracoacromial artery. Together with the pectoralis minor it aids the pectoralis major in forming the anterior wall of the axilla. Superiorly it splits to enclose the subclavius muscle. Cut through the costocoracoid membrane just below the clavicle to expose this muscle. The subclavius is a small muscle which arises from the first rib and its cartilage near their junction and runs upward and laterally to be inserted into a groove on the under surface of the middle third of the clavicle. The axilla may now be completely opened from the front by removal of the costocoracoid membrane and reflection of the pectoralis minor. Detach

the pectoralis minor from its origin on the ribs and turn it upward to its insertion. As this is done, the medial anterior thoracic nerve, whose terminal portion has already been seen entering the pectoralis major, will

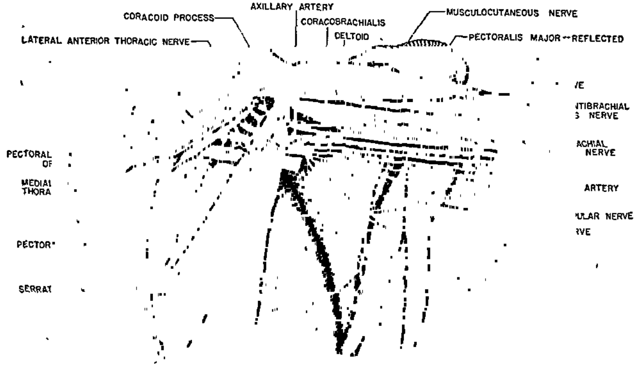

Fig. 1.—The axilla, opened from the front by reflection of the pectoralis major.

be found entering the deep surface of the pectoralis minor, which it also supplies. This nerve should be preserved for future reference.

THE AXILLA

The axilla is a roughly pyramidal space lying between the upper part of the arm and the upper lateral thoracic wall. Its anterior wall has already been studied and removed; its remaining boundaries will be exposed as the dissection proceeds. The medial wall of the axilla is formed by the upper ribs and intercostal muscles, covered externally for the most part by the serratus anterior muscle. Its narrow lateral wall is formed by the medial surface of the upper part of the humerus, covered by the coracobrachialis muscle. Its posterior wall, which extends farther inferiorly than does the anterior wall, is formed from above downward and laterally by the subscapularis, teres major, and latissimus dorsi muscles. The apex of the axilla is a triangular gap bounded by the first rib, the upper border of the scapula, and the posterior border of the clavicle, and known as the cervico-axillary canal, through which the axilla communicates with the

posterior triangle of the neck. The base or floor of the axilla is formed by the axillary fascia and skin.

The important structures contained within the axilla, and to be displayed in its dissection are the axillary vein and its tributaries, the axillary artery and its branches, the lower part of the brachial plexus of nerves, and the numerous nerves which arise from this plexus. These structures are embedded in a mass of fat and fascia, which completely fills the axillary space. The dissection of the axilla consists in the removal of the axillary fascia and fat without injury to the structures embedded in it. As the fat is removed numerous lymph glands will also be found within it. Their form and position should be noted but they need not be retained.

The nerves and vessels entering the arm from the lateral part of the axilla should first be exposed. Start by removing the deep fascia from the upper part of the arm, where it forms the lateral wall of the axilla. This will expose the coracobrachialis muscle and the short head of the biceps brachii, which arise together from the coracoid process of the scapula. Descending along the medial border of the coracobrachialis the large median nerve will be found. Immediately medial to the median nerve the distal part of the axillary artery should be exposed and cleaned. Medial to the artery is the ulnar nerve. This latter nerve may be overlapped by the axillary vein, whose general position is medial and somewhat anterior to the artery. Also medial to the axillary artery and closely related to the axillary vein will be found the medial cutaneous nerve of the forearm (medial antibrachial cutaneous nerve) and the medial cutaneous nerve of the arm (medial brachial cutaneous nerve). The former, while smaller than the median and ulnar nerves, is still a nerve of considerable size; the latter is a relatively small nerve, usually medial to the former, and is distributed to the skin on the postero-medial aspect of the arm. It usually communicates by an anastomosing branch with another small nerve, the intercostobrachial. This nerve will be found in the fascia near the floor of the axilla. It is the lateral cutaneous branch of the second intercostal nerve, which emerges from the second intercostal space and crosses the axilla to reach the medial aspect of the arm. Now push the coracobrachialis laterally and expose the musculocutaneous nerve. This nerve lies lateral to the median nerve in the upper part of the arm and disappears from view by entering the substance of the coracobrachialis. Trace the median nerve proximally

and observe that it is formed at about the level of the outer margin of pectoralis minor by the junction of two smaller nerve trunks. These a known as the lateral and medial heads of the median nerve. The media head crosses in front of the axillary artery. If the distal part of the axillary artery is now drawn forward and medially, a very large nerve which lies immediately behind it in the lateral part of the axilla, may be exposed. This is the radial nerve.

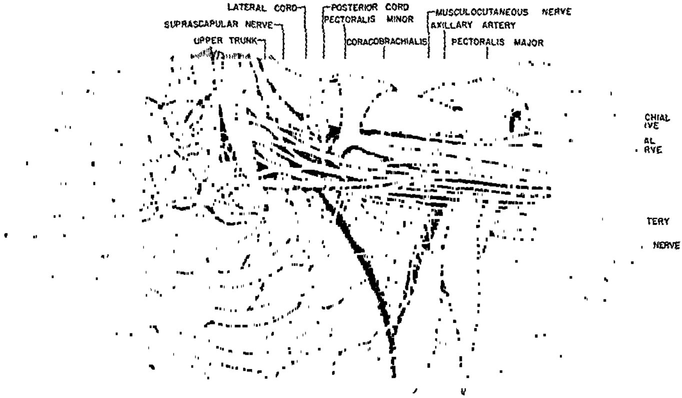

FIG. 2.—Complete dissection of the brachial plexus. The medial end of the clavicle has been removed, and both pectoral muscles reflected.

The various nerves which have been exposed are the terminal branches of the brachial plexus. Their distribution can not be studied until the arm is dissected, but they may be traced back to their origins in the more medial parts of the axilla. Before doing this, however, it is well to have a general idea of the plan of the brachial plexus and its relation to the axillary artery.

The brachial plexus is derived from the anterior rami of the fifth, sixth, seventh and eighth cervical and the first thoracic nerves. These nerves, which are known as the roots of the plexus, are situated in the posterior triangle of the neck. Here they combine to form the trunks of the plexus, as follows: the fifth and sixth cervical roots form the upper trunk, the seventh cervical alone forms the middle trunk, and the eighth cervical

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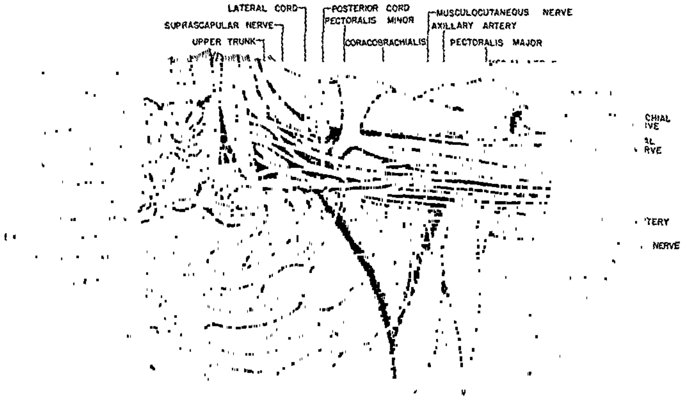

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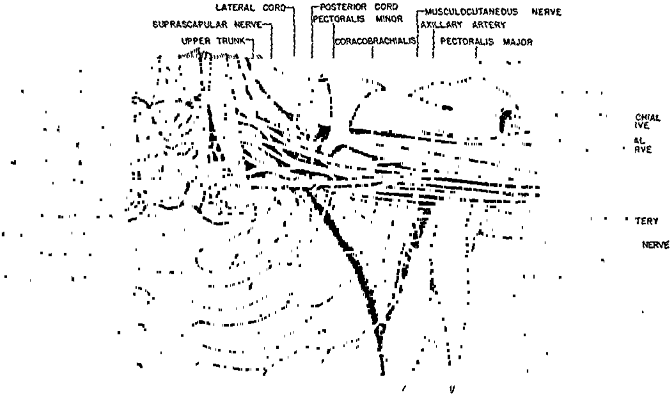

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racic the lower trunk. The three trunks enter the upper of the axilla through the cervico-axillary canal, and each breaks nterior and a posterior branch, which are recombined to form the plexus. The lateral cord is formed by the anterior branches per and middle trunks, *the medial cord is a direct continuation of* rior branch of the lower trunk, and the posterior cord is formed by on of all three posterior branches. The three cords are grouped the middle portion of the axillary artery in positions corresponding to their names. The nerves already exposed in the lateral part of the axilla are derived from these three cords. Before tracing them back to the various cords, the axillary vessels should be studied.

The axillary vein, while usually described as a single channel, is often found to consist of two or more parallel anastomosing vessels. Its tributaries, insofar as they are constant, correspond to and accompany the branches of the axillary artery. Having once observed the important fact that throughout its course the axillary vein lies medial and somewhat anterior to the artery, the dissector is advised to pay no further attention to the veins, but simply to cut them away whenever by so doing he may facilitate the cleaning and study of the arteries and nerves.

Clean and study the axillary artery and its branches. The axillary artery is an arbitrary anatomical subdivision of the great arterial channel *which supplies the superior extremity. It begins at the outer border of* the first rib as a direct continuation of the subclavian artery, and ends at the outer border of the teres major muscle (which corresponds roughly to the lateral part of the posterior axillary fold), beyond which point its continuation is known as the brachial artery. It is further arbitrarily divided for descriptive purposes into three parts. Of these the first is medial to the pectoralis minor and consequently posterior to the costocoracoid membrane, *the second lies behind the pectoralis minor,* and the third and longest part is lateral to the pectoralis minor. Observe that the distal half of the third part, where it extends beyond the lower border of the pectoralis major, is quite superficial, being covered only by the fascia and skin.

The branches of the axillary artery are subject to some variation, but in the majority of cases are as follows. From the first part arises a small branch, the supreme thoracic, distributed to the upper part of the thoracic wall. From the second part, near its beginning, arises the thoracoacromial

artery. This is a short thick trunk, some of whose branches have alr been met, which runs forward into the costocoracoid membrane to break into a group of radiating branches, which are described, from the region they supply, as deltoid, pectoral, acromial, and clavicular. The lateral thoracic artery arises from the middle of the second part of the axillary, and runs downward under cover of the pectoralis minor to be distributed to the lateral thoracic wall and the pectoral muscles.

The third part of the axillary artery has three branches which all arise close together at about the middle of its course. The anterior humeral circumflex artery is a small branch which arises from the antero-lateral aspect of the axillary and runs laterally across the front of the arm to disappear behind the coracobrachialis muscle. The posterior humeral circumflex is considerably larger. It arises from the posterior aspect of the axillary, and runs backward and downward to disappear almost at once into a groove in the posterior wall of the axilla. Accompanying the artery into this groove, which lies between the adjacent borders of the subscapularis and teres major muscles, will be found a large nerve, not previously uncovered. This is the axillary nerve. Running downward from the axillary artery in close relation to the posterior wall of the axilla is the subscapular artery. About an inch below its origin it ends by dividing into the thoracodorsal and scapular circumflex arteries. The scapular circumflex leaves the axilla by passing backward into the groove between the subscapularis and the teres major. The thoracodorsal continues its descent on the posterior wall of the axilla and is distributed chiefly to the latissimus dorsi and teres major muscles. In cleaning it, secure the nerve of supply to the latissimus dorsi. This is the thoracodorsal nerve, which runs downward and laterally in the fat on the posterior wall of the axilla, to be distributed to the latissimus dorsi in company with branches of the thoracodorsal artery. (Fig. 2.)

Now complete the study of those parts of the brachial plexus which lie in the axilla. Begin with the lateral cord. This lies lateral to the second part of the axillary artery and may be identified by tracing proximally the musculocutaneous nerve and the lateral head of the median nerve, which are its terminal branches. Its only other branch is the lateral anterior thoracic nerve, which was previously identified and should now be traced to its origin. Trace the lateral cord proximally and identify the anterior branches of the upper and middle trunks, which join to form it.

racic the lower trunk. The three trunks enter the upper of the axilla through the cervico-axillary canal, and each breaks anterior and a posterior branch, which are recombined to form of the plexus. The lateral cord is formed by the anterior branches per and middle trunks, the medial cord is a direct continuation of rior branch of the lower trunk, and the posterior cord is formed by ction of all three posterior branches. The three cords are grouped the middle portion of the axillary artery in positions corresponding to their names. The nerves already exposed in the lateral part of the axilla are derived from these three cords. Before tracing them back to the various cords, the axillary vessels should be studied.

The axillary vein, while usually described as a single channel, is often found to consist of two or more parallel anastomosing vessels. Its tributaries, insofar as they are constant, correspond to and accompany the branches of the axillary artery. Having once observed the important fact that throughout its course the axillary vein lies medial and somewhat anterior to the artery, the dissector is advised to pay no further attention to the veins, but simply to cut them away whenever by so doing he may facilitate the cleaning and study of the arteries and nerves.

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ial cord lies medial to the second part of the axillary artery. branches are the ulnar nerve and the medial head of the median crosses in front of the third part of the axillary artery. Proxitermination the medial cord gives rise to the medial cutaneous e forearm, the medial cutaneous nerve of the arm, and the medial horacic nerve, all of which have already been identified. As the rd is traced proximally, it will be found to be a direct continuation nterior branch of the lower trunk.

The posterior cord lies behind the second part of the axillary artery. Its two large terminal branches, the axillary and radial nerves, have been identified and may now be traced back to their origins. Its other branches are three smaller nerves, the upper and lower subscapular nerves, and the thoracodorsal. The latter has already been seen as the nerve of supply to the latissimus dorsi. The subscapular nerves will be found by dissecting in the fat close to the posterior wall of the axilla. The upper subscapular, often represented by two branches, supplies the subscapularis, and the lower subscapular the teres major. The two subscapular nerves and the thoracodorsal often arise from the posterior cord by a common trunk and sometimes appear to arise from the axillary nerve rather than directly from the posterior cord. Trace the posterior cord proximally and observe that it is formed by the union of the posterior branches of all three trunks.

As the final step in the dissection of the axilla, clear away the fascia from its medial wall to expose the serratus anterior muscle and long thoracic nerve. The seratus anterior is a large flat muscle which arises by a series of pointed slips from the outer surfaces of the first eight ribs about an inch lateral to their junction with their cartilages. Its fibres run posteriorly around the thoracic wall, to be inserted into the inner aspect of the vertebral border of the scapula along its entire length. It is supplied by the long thoracic nerve. This nerve will be found running downward over the external surface of the muscle in about the mid-axillary line. It is derived in the posterior triangle of the neck, from the fifth, sixth, and seventh cervical nerves.

THE TRIANGLES OF THE NECK

The anterior and posterior triangles of the neck are regions whic. depend for their anatomical recognition principally upon the position of the sternomastoid muscle. The anterior triangle, of which the apex is directed inferiorly, lies in front of the sternomastoid, whose anterior border forms the postero-lateral boundary of the triangle; its superior boundary is formed by the lower border of the mandible, and its medial boundary is formed arbitrarily by the median line of the neck, from the mandibular symphysis to the jugular notch of the sternum. It is only by this line that the anterior triangles of the two sides are separated from each other. The posterior triangle, of which the apex is directed superiorly, lies behind the sternomastoid, whose posterior border forms its anterior boundary; its inferior boundary is formed by the middle third of the clavicle, and its posterior boundary is formed by the anterior border of the trapezius muscle. (Fig. 3.)

The skin should now be reflected in a single flap from the surface of both triangles and the sternomastoid muscle. For this purpose three skin incisions should be made: (1) a median incision running from the mental protuberance downward to the jugular notch; (2) from the upper end of incision one backward and laterally along the inferior border of the mandible to the angle, and then backward and somewhat upward, to pass below the ear, across the mastoid process, and for about an inch along the superior nuchal line; (3) from the lower end of incision one laterally along the clavicle to the acromion. The large flap of skin thus marked out should then be reflected backward and laterally from the front and side of the neck. As this is done, be extremely careful to reflect the skin cleanly away from the underlying fascia, particularly as the posterior portion of the area is reached, since if the skin is carelessly reflected in this region, the anterior border of the trapezius is liable to injury, or even to reflection with the skin. The superficial fascia which is exposed by the reflection of the skin shows no particular characteristics differentiating it from the same layer in other regions, except that it is extremely thin.

Clean the platysma, by the removal of the superficial fascia which covers it. This thin, sheet-like muscle belongs to the general group of the muscles of facial expression and is often poorly developed. Do not mistake the fibres of the sternomastoid for those of the platysma; this confusion can

y observation of the direction in which the fibres run. The ses from the skin and superficial fascia covering the upper porpectoralis major; from here its fibres pass upward and medially lavicle in a broad flat sheet which covers the lower anterior part erior triangle, the lower two-thirds of the sternomastoid, and the eral part of the anterior triangle; it is inserted into the inferior the mandible and the skin of the lower part of the cheek and the the mouth. This latter part of its insertion can not be seen at sent. When the platysma has been cleaned and observed it should be reflected, from the clavicle upward and medially to the lower border of the mandible. This must be done with care, to avoid injury to the nerves and vessels which lie immediately subjacent to the platysma. As the angle of the mandible is approached, attempt to secure the cervical branch of the facial nerve, which emerges from behind the lower part of the parotid gland, to enter the deep surface of the platysma, which it supplies. Observe that the lower tip of the parotid gland fills in the narrow interval between the posterior border of the ramus of the mandible and the anterior border of the sternomastoid. The main body of the parotid is still covered by the skin of the face.

Now clean the sternomastoid muscle, cleaning at the same time, and retaining in position, the structures which cross its external surface. These are the external jugular vein and four nerves, the lesser occipital, the great auricular, the cervical cutaneous (n. cutaneus colli), and the anterior supraclavicular. These nerves are cutaneous branches of the cervical plexus; they become superficial by piercing the deep fascia of the posterior triangle close to the posterior border of the sternomastoid, and turn forward across that muscle. The lesser occipital nerve crosses the upper posterior part of the sternomastoid, to be distributed to the skin of the lower lateral part of the scalp. The great auricular nerve runs upward and slightly forward over the upper half of the sternomastoid, to supply the skin of this part of the neck, a small part of the skin of the face in the region of the angle of the mandible, and the posterior part of the auricle. The cervical cutaneous nerve crosses the sternomastoid transversely at about its middle, to supply the skin over the anterior triangle. The anterior supraclavicular nerve crosses the lower lateral portion of the sternomastoid, to be distributed to the skin in the region of the sternoclavicular articulation. (Fig. 3.)

The external jugular vein is somewhat variable in size, and occasionally entirely missing. Typically it is formed on the sternomastoid below and behind the angle of the mandible, by the junction of the posterior auricular vein with a branch of the posterior facial. It descends across the sternomastoid and pierces the deep fascia of the lower anterior part of the posterior triangle to terminate in the subclavian vein.

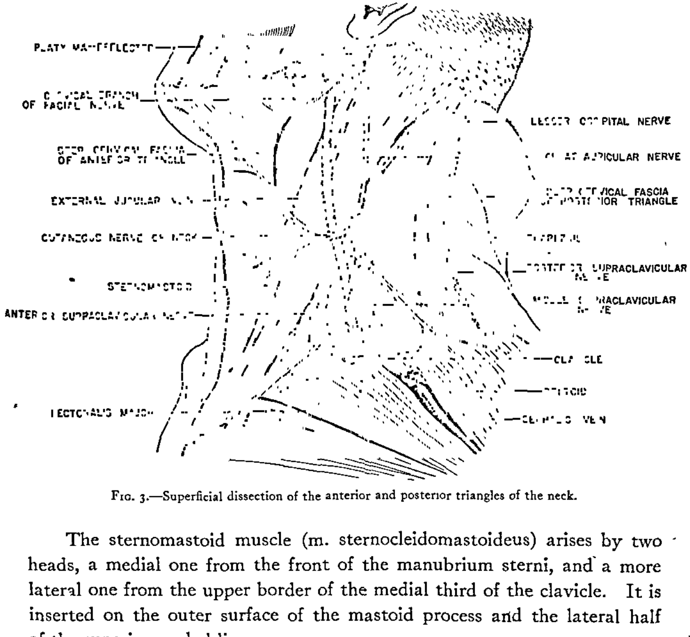

Fig. 3.—Superficial dissection of the anterior and posterior triangles of the neck.

The sternomastoid muscle (m. sternocleidomastoideus) arises by two heads, a medial one from the front of the manubrium sterni, and a more lateral one from the upper border of the medial third of the clavicle. It is inserted on the outer surface of the mastoid process and the lateral half of the superior nuchal line.

When the sternomastoid and the structures crossing it have been cleaned and studied proceed to the dissection of the posterior triangle. For this dissection the shoulder should be depressed, and the head turned as far as possible to the opposite side.

The trapezius muscle can not be studied as a whole until the back is dissected. Its upper anterior border should now be cleaned, however, in order completely to define the boundaries of the posterior triangle. This border runs downward and laterally from about the middle of the superior nuchal line to the upper border of the clavicle at about the junction of its middle and lateral thirds. The superficial boundary or roof of the posterior triangle is formed by a layer of the deep cervical fascia which stretches between the sternomastoid and the trapezius and is limited inferiorly by the clavicle. This fascia is pierced by the structures which have already been seen to cross the sternomastoid, and by the remaining supraclavicular nerves, which should now be identified. The supraclavicular nerves are all derived, as will be apparent later, from a single trunk that arises from the lowest loop of the cervical plexus. They pierce the deep fascia of the posterior triangle usually as three separate trunks, anterior, middle, and posterior, supply the skin over the lower part of the posterior triangle, and descend across the clavicle to supply the skin covering the upper part of the pectoralis major and the region of the acromion. Posterior supraclavicular branches cross the trapezius superficially. (Fig. 3.)

The deep boundary or floor of the posterior triangle is formed by the external surfaces of several of the deeper muscles of the neck. The actual extent of the triangle is the space, much deeper below than above, which intervenes between this muscular floor and the fascial roof. This space contains numerous important structures and is further completely filled by a mass of fatty areolar tissue. The further dissection of the posterior triangle consists in the cleaning of the structures contained within it and the muscles which make up its floor by the careful removal of the fascia and fat. It should be noted that inferiorly the posterior triangle is directly continuous with the axilla by means of a triangular aperture known as the cervico-axillary canal; this canal is bounded by the clavicle, the upper border of the scapula, and the first rib. The muscles which form the floor of the triangle are, from above down, the splenius capitis, the levator scapulae, and the scalenus medius and posterior. Only a portion of each of these muscles appears in the triangle, but they should be identified as the dissection proceeds. The scalenus anterior sometimes appears in the lower anterior corner of the triangle, but is usually completely covered by the sternomastoid.

The cutaneous nerves which have already been displayed should now be traced back to the points at which they emerge from under cover of the posterior border of the sternomastoid. The cervical plexus, from which all of these nerves arise, is under cover of the sternomastoid and will be displayed later, when that muscle is reflected. Next identify and clean the

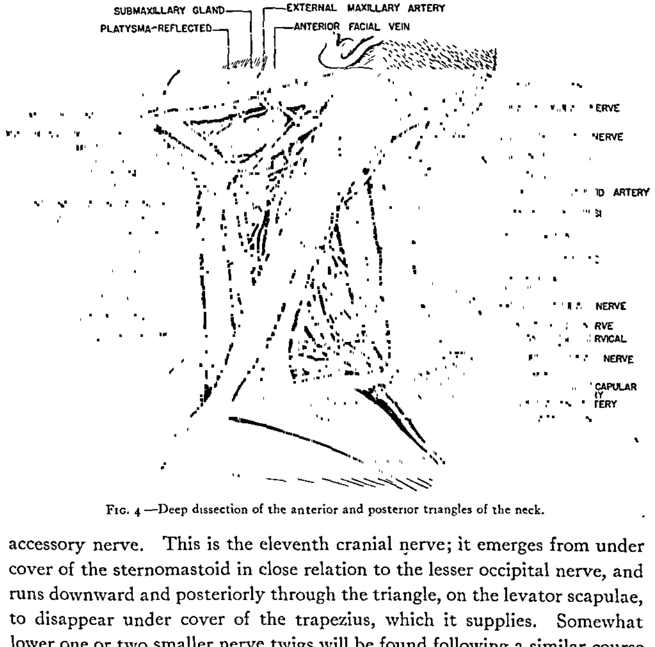

FIG. 4.—Deep dissection of the anterior and posterior triangles of the neck.

accessory nerve. This is the eleventh cranial nerve; it emerges from under cover of the sternomastoid in close relation to the lesser occipital nerve, and runs downward and posteriorly through the triangle, on the levator scapulae, to disappear under cover of the trapezius, which it supplies. Somewhat lower one or two smaller nerve twigs will be found following a similar course through the triangle; these are muscular branches of the cervical plexus, for the additional supply of the trapezius. (Fig. 4.)

Clean the posterior belly of the omohyoid muscle. This narrow, band-like muscle enters the lower part of the triangle from the interval behind the sternomastoid and in front of the scalenus anterior, and runs downward and

backward to its attachment on the superior border of the scapula. On a slightly deeper plane the transverse cervical artery may be exposed and cleaned. This vessel is a branch of the thyrocervical trunk of the subclavian artery; emerging from behind the sternomastoid it crosses the posterior triangle about half an inch above, and roughly parallel to the clavicle, to divide into two branches, the ascending and the descending. The ascending branch passes laterally under cover of the trapezius. The descending branch enters the floor of the triangle in the interval between the scalenus medius and the levator scapulae. The origin of the transverse cervical artery is somewhat variable, however, and if it does not appear in its typical position, it will probably be found later as a direct branch of the third part of the subclavian artery.

Attention should next be directed to the roots and trunks of the brachial plexus, which lie deeply in the lower anterior part of the posterior triangle. The roots of the plexus are the anterior rami of the fifth, sixth, seventh and eighth cervical, and the first thoracic nerves. They pass downward and laterally into the triangle from the interval behind the scalenus anterior and in front of the scalenus medius, and combine to form the upper, middle, and lower trunks of the plexus; the trunks continue their course downward and laterally, resting against the scalenus medius, to enter the axilla through the cervico-axillary canal.

Clean first the upper trunk. This is formed by the junction of the anterior rami of the fifth and sixth cervical nerves, and gives rise to two branches in the posterior triangle. These are the suprascapular nerve and the nerve to the subclavius. The latter is a small twig which passes downward and forward through the areolar tissue of the lower part of the triangle, and behind the clavicle, to supply the subclavius muscle. The suprascapular nerve is a much larger branch, which passes laterally toward the upper border of the scapula. The middle trunk of the plexus lies below the upper trunk; it is a direct continuation of the anterior ramus of the seventh cervical nerve; it has no branches in the posterior triangle. The lower trunk is formed by the junction of the anterior rami of the eighth cervical and first thoracic nerves; its course in the posterior triangle is very short and it also is devoid of branches in this area.

Identify and clean the dorsal scapular and the long thoracic nerves. These are both derived from the upper roots of the plexus, but their origin

is too far medial to be seen at present. They will be found to enter the triangle through the substance of the scalenus medius and pass downward on the surface of that muscle, inclining somewhat posteriorly. The dorsal scapular nerve is the higher of the two; it leaves the triangle by entering its floor in the interval between the scalenus medius and the levator scapulae in close relation to the descending branch of the transverse cervical artery. The long thoracic nerve takes a more nearly vertical course and passes behind the trunks of the plexus into the axilla. (Fig. 4.)

Clean the portions of the subclavian vein and the subclavian artery which are at present available for study. The subclavian vein lies immediately behind the clavicle in the lower anterior corner of the posterior triangle, and passes medially behind the sternomastoid and in front of the scalenus anterior. It receives in this region the termination of the external jugular vein. Behind the subclavian vein the transverse scapular artery will be found emerging from in front of the scalenus anterior, to cross the lowest part of the posterior triangle and join the suprascapular nerve close to the upper border of the scapula. The second part of the subclavian artery lies behind the scalenus anterior, by which it is separated from the vein; the third part extends from the outer border of the scalenus anterior to the outer border of the first rib, and should now be cleaned. It rests on the upper surface of the first rib and lies below and in front of the lower trunk of the brachial plexus; at the outer border of the first rib it becomes the axillary artery. It has typically no branches, but occasionally either the transverse cervical or the transverse scapular artery, or both, may arise from it.

THE ANTERIOR TRIANGLE

The anterior triangle is also roofed by a layer of the deep cervical fascia. This fascia stretches from the anterior border of the sternomastoid muscle of one side to that of the other. Superiorly it is attached to the lower border of mandible and more posteriorly blends with the fascia forming the sheath of the parotid gland. It is firmly attached to the body of the hyoid bone, whose position should be determined by palpation. Inferiorly the fascia splits into anterior and posterior layers which are attached to the anterior and posterior borders, respectively, of the jugular notch of the sternum, and enclose between them an areolar-tissue-filled space

known as the supra-sternal space. On the external surface of this fascia is the anterior jugular vein. This vein is formed by several small veins in the region of the mental protuberance and descends just lateral to the median line, to enter the supra-sternal space. Just above the manubrium it turns laterally behind the sternomastoid, to terminate in the external jugular or the subclavian vein. It shows variable communications with other veins, and is apt to be particularly large if the external jugular is small.

The layer of deep cervical fascia which forms the roof of the anterior triangle must be carefully removed, to expose the structures which lie beneath it. Clean first the digastric muscle. The two bellies of this muscle have the form of a wide V. The anterior belly arises from the digastric fossa of the mandible; the posterior belly arises from the mastoid notch of the temporal bone. The latter attachment is at present hidden by the mastoid process and the sternomastoid muscle. The two bellies narrow to an intermediate tendon which lies just above the lateral part of the body of the hyoid bone, to which it is bound by a slip of the deep cervical fascia. In close relation to the posterior belly will be found the stylohyoid muscle. This slender muscle arises from the base of the styloid process and is inserted on the hyoid bone near the junction of the body and the greater cornu; it is usually pierced near its insertion by the intermediate tendon of the digastric. Crossing the posterior belly of the digastric and the stylohyoid externally will be found the common facial vein, which should be preserved. (Fig. 4.)

Identify the position of the thyroid cartilage. This cartilage, which forms the prominence of the larynx commonly known as the Adam's apple, lies a short distance below the hyoid bone, to which it is connected by the thyrohyoid membrane. Both cartilage and membrane are at present largely covered by the infra-hyoid muscles, which should now be cleaned. This group of flat, band-like muscles includes the sternohyoid, the omohyoid, the sternothyroid, and the thyrohyoid. The sternohyoid arises from the inner surfaces of the manubrium sterni and the capsule of the sternoclavicular joint; its fibres run almost vertically upward to be inserted on the lower border of the hyoid bone just lateral to the median line. The posterior belly of the omohyoid has already been seen in the posterior triangle, where it takes origin from the upper border of the scapula; the intermediate

tendon lies behind the sternomastoid; the anterior belly runs upward and forward through the anterior triangle, to be inserted on the hyoid bone just lateral to the insertion of the sternohyoid. The sternothyroid and thyrohyoid muscles are partially covered externally by the two muscles just described. The sternothyroid arises from the inner surface of the manubrium, below the origin of the sternohyoid, and is inserted on an oblique line on the lamina of the thyroid cartilage. The thyrohyoid arises from this same line on the thyroid cartilage and is inserted on the lower border of the hyoid bone under cover of the insertions of the sternohyoid and the omohyoid. Unless the sternothyroid and the thyrohyoid are carefully cleaned, they will appear to be one continuous muscle.

Observe that by means of the digastric and the omohyoid muscles the anterior triangle of the neck is subdivided into three subsidiary triangular spaces, which are known as the digastric, the carotid, and the muscular triangles. The muscular triangle is bounded by the midline of the neck below the hyoid bone, the posterior border of the anterior belly of the omohyoid, and the anterior border of the lower half of the sternomastoid; its principal contents are the infra-hyoid muscles, which have already been cleaned. The carotid triangle is bounded by the posterior border of the omohyoid, the anterior border of the upper half of the sternomastoid, and the lower border of the posterior belly of the digastric. The digastric triangle, to which attention will next be directed, is bounded by the two bellies of the digastric, and the lower border of the mandible. Bounded by the anterior bellies of the digastric muscles of the two sides is a small triangular space common to both sides, known as the submental triangle.

The principal structures now to be exposed in the digastric triangle are the submaxillary gland, the external maxillary artery, the mylohyoid nerve, and the mylohyoid muscle, which latter forms the floor of the triangle. Identify the external maxillary artery and the anterior facial vein at the point where they cross the lower border of the mandible. This is about three quarters of an inch anterior to the angle, the artery usually lying somewhat anterior to the vein. Observe that the vein crosses the digastric triangle superficially and joins a branch of the posterior facial vein which emerges from the parotid gland, to form the common facial vein. This crosses the digastric externally, as already noted, and enters the carotid triangle, to terminate usually in the internal jugular vein. Occasionally it joins the

external jugular, or, more rarely, the anterior jugular. The course of the external maxillary artery in the digastric triangle is at present hidden by the submaxillary gland, which should now be cleaned. (Fig. 4.)

The large superficial portion of the submaxillary gland occupies most of the space of the digastric triangle. It presents three surfaces, a flat superficial surface, covered only by skin, fascia, and platysma; a deep surface, which is in relation to the mylohyoid muscle; and a narrow lateral surface, which is in relation to the submaxillary fossa on the inner surface of the mandible. *Displace the gland downward and medially to expose the latter two surfaces,* and observe that a thin-walled duct emerges from the deep surface and passes forward under cover of the posterior border of the mylohyoid muscle. Accompanying the duct is a narrow process of the glandular substance, which is known as the deep portion of the gland.

Clean the portion of the external maxillary artery which lies in the digastric triangle. Arising in the carotid triangle as a branch of the external carotid, this vessel enters the digastric triangle by passing deep to the stylohyoid and digastric muscles. It passes upward and laterally in a groove on the deep surface of the submaxillary gland, and then bends downward on the inner surface of the mandible to the lower border of that bone, around which it turns, as has already been seen, to reach the face. In the digastric triangle it gives rise to glandular branches and to a submental branch, which passes forward to be distributed to the digastric and mylohyoid muscles. In close relation to the submental artery is the terminal part of the mylohyoid nerve, whose origin as a branch of the mandibular nerve will be seen later. Descending along the inner surface of the mandible, it reaches the digastric triangle, where it supplies the mylohyoid muscle and the anterior belly of the digastric. (Fig. 4.)

Clean the mylohyoid muscle. This is a flat sheet of muscle, which forms the floor of the digastric and submental triangles. Arising from the mylohyoid line on the inner surface of the mandible, its fibres pass downward and medially to be inserted into the body of the hyoid bone and a median raphe which extends from the hyoid bone to the lower end of the mandibular symphysis.

Attention should now be turned to the carotid triangle. The principal structures contained here are the hypoglossal nerve, portions of the internal jugular vein, the common, internal, and external carotid arteries, and some

of the branches of the latter. Dissect in the fascia about a quarter of an inch above the greater cornu of the hyoid bone and expose the hypoglossal nerve, where it rests against the hyoglossus muscle. Traced forward it will be found to pass deep to the stylohyoid and then to disappear under cover of the mylohyoid. Traced backward it bends upward to disappear under cover of the posterior belly of the digastric. Just below the digastric it is crossed externally by the occipital artery. The hyoglossus is one of the extrinsic muscles of the tongue. It is for the most part covered at present by the digastric and the mylohyoid, but a small portion of it enters into the floor of the carotid triangle, its fibres running upward from the greater cornu of the hyoid bone. Close to the posterior border of this muscle the hypoglossal nerve gives rise to a small branch which runs downward and forward to supply the thyrohyoid muscle. (Fig. 4.)

The further dissection of the carotid triangle consists largely in the removal of a portion of the carotid sheath. This is the fascial sheath which encloses the carotid arteries, the internal jugular vein, and the vagus nerve. It is not a distinct membranous sheath, but merely a condensation of fascia, in which these structures are embedded.

The internal jugular vein, unless it is unusually large and filled with blood, will appear only in the upper angle of the carotid triangle, since the lower part of its course is completely overlapped by the sternomastoid. The lower part of the common carotid artery is also covered by the sternomastoid, but its terminal portion may now be exposed, just in front of the sternomastoid and behind the thyroid cartilage. The common carotid ends at about the level of the upper border of the thyroid cartilage, by dividing into internal and external carotids. Clean the external carotid and its branches, in so far as they lie within the carotid triangle. (Fig. 4.)

At its origin the external carotid lies anterior to the internal. It ascends in the neck, inclining somewhat posteriorly, so that it comes to lie lateral to the internal carotid, and passes from view under cover of the posterior belly of the digastric. The first branch of the external carotid is usually the ascending pharyngeal. This is a small vessel which arises from the inner surface of the external carotid and ascends deeply on the pharyngeal wall; it is best left for study until a later stage in the dissection. From the anterior aspect of the external carotid arise the superior thyroid, the lingual, and the external maxillary arteries, which should now be identified.

The superior thyroid arises a short distance above the origin of the external carotid and runs forward, medially, and then downward, eventually to reach the thyroid gland, under cover of the omohyoid muscle. It gives rise near its origin to a small hyoid branch, and shortly after it bends downward, to a larger superior laryngeal branch, which runs forward to pierce the thyrohyoid membrane and enter the larynx.

The lingual artery arises at about the level of the greater cornu of the hyoid bone, and runs forward, usually with a slight upward bend, to disappear under cover of the hyoglossus muscle.

The external maxillary artery arises slightly above the lingual, or not uncommonly by a common stem with the latter vessel, and running forward and upward, passes under cover of the posterior belly of the digastric, to reach the digastric triangle, where its further course has already been seen.

From its posterior aspect, the external carotid gives rise, close to the lower border of the digastric muscle, to the occipital artery. This vessel runs backward and upward, crossing the internal jugular vein externally, and is soon hidden by the digastric and sternomastoid muscles.

Attempt to display the internal and external laryngeal nerves. These are the terminal branches of the superior laryngeal branch of the vagus, but that fact can not be demonstrated at present. Both run downward and forward, deep to both internal and external carotid arteries. The internal nerve passes deep to the lingual artery near the origin of that vessel, and pierces the thyrohyoid membrane in company with the superior laryngeal artery. The external laryngeal nerve is considerably smaller and will be found at a slightly lower level. Crossing deep to the superior thyroid artery, it passes under cover of the sternothyroid muscle, to supply the cricothyroid, one of the intrinsic muscles of the larynx. (Fig. 4.)

STRUCTURES UNDER COVER OF THE STERNOMASTOID

Detach the sternomastoid from its origin, and reflect it upward and laterally to its insertion. The success of the later dissection of the neck depends to a large extent on the completeness of the reflection of the sternomastoid; reflect the muscle clear back to its attachment to the skull. As the upper part of the muscle is reflected, observe that there is, in relation to its deep surface in the region below and behind the angle of the mandible, a considerable aggregation of large deep cervical lymph glands. When these

have been observed they should be carefully but completely removed, together with the mass of fatty areolar tissue in which they are embedded. As this is done, secure the accessory nerve. This nerve emerges from under cover of the posterior belly of the digastric, behind the internal jugular vein, and runs downward and posteriorly across the deep surface of the sternomastoid, to enter the posterior triangle. As it crosses the deep surface of the sternomastoid it gives branches of supply to that muscle. Entering the deep

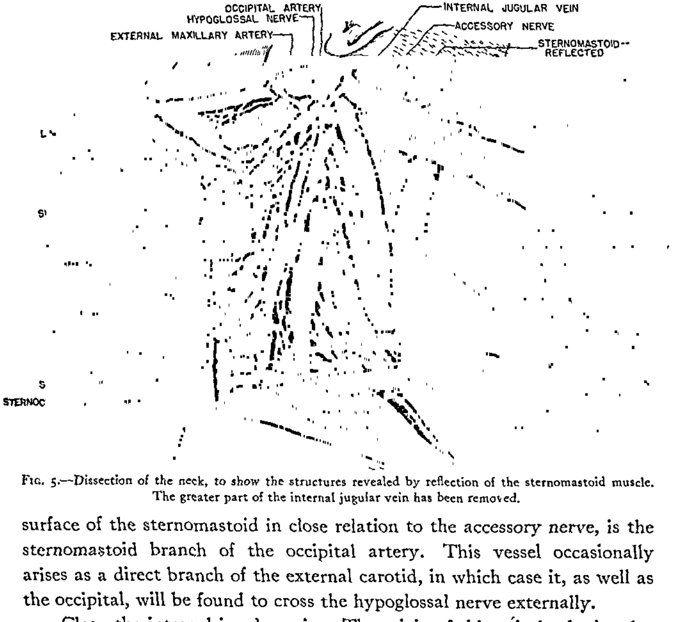

FIG. 5.—Dissection of the neck, to show the structures revealed by reflection of the sternomastoid muscle. The greater part of the internal jugular vein has been removed.

surface of the sternomastoid in close relation to the accessory nerve, is the sternomastoid branch of the occipital artery. This vessel occasionally arises as a direct branch of the external carotid, in which case it, as well as the occipital, will be found to cross the hypoglossal nerve externally.

Clean the internal jugular vein. The origin of this vein in the jugular foramen can not now be seen. The internal jugular emerges from under cover of the digastric and descends through the neck deep to the sternomastoid; it terminates behind the sternoclavicular articulation by joining the subclavian vein to form the innominate vein. It is crossed externally

by the intermediate tendon of the omohyoid muscle, and often by the descending cervical root of the ansa hypoglossi. It is enclosed in the carotid sheath, where it lies lateral to the internal carotid artery above, and the common carotid below. The tributaries of the internal jugular vein, with the exception of the common facial vein, correspond roughly to the lower branches of the external carotid artery.

Clean the ansa hypoglossi. This is a nerve loop, which is formed by the descending branch of the hypoglossal nerve (descendens hypoglossi) and a branch derived from the second and third cervical nerves (descendens cervicalis). The descendens hypoglossi arises from the hypoglossal nerve near the point at which that nerve emerges from under cover of the digastric, and descends in close relation to the external aspect of the carotid sheath. The descendens cervicalis arises by two roots, from the second and third cervical nerves, and runs downward and forward, passing either superficial or deep to the internal jugular vein; it joins at an extremely variable level the descendens hypoglossi to form the loop known as the ansa hypoglossi. From the lower end of this loop branches descend to supply the sternohyoid, the sternothyroid, and both bellies of the omohyoid. (Fig. 5.)

Attention should next be directed to the cervical plexus. This is a looped nerve plexus derived from the anterior rami of the first four cervical nerves; it lies under cover of the upper part of the sternomastoid muscle. The anterior ramus of the first nerve is small and difficult to expose. It emerges above the transverse process of the atlas and turns downward in front of that process to join the second nerve. The second, third, and fourth nerves are each successively larger and enter the present area of dissection by passing laterally and downward from between the anterior and posterior tubercles of the transverse processes of the corresponding cervical vertebrae. The plexus proper takes the form of three loops. The first is that already noted between the first and second nerves, and lies in front of the transverse process of the atlas. The second loop is formed by the second and third nerves, and the third by the third and fourth nerves. These loops are longer and more laterally directed, and rest against the levator scapulae and scalenus medius. The cutaneous branches of the cervical plexus, which have already been seen in the dissection of the posterior triangle, should now be traced back to their origins. The lesser occipital, great auricular, and cervical cutaneous nerves all arise from the loop between the second and

third nerves. Anterior, middle, and posterior supraclavicular nerves arise from the lower loop, usually by a common stem. From this loop are also derived muscular twigs, which cross the posterior triangle to reach the deep surface of the trapezius.

Muscular branches arise also from the roots of the cervical plexus. The largest of these is the phrenic nerve. This nerve is derived principally from the fourth cervical and passes downward and medially on the anterior surface of the scalenus anterior, to enter the thoracic cavity behind the innominate vein. It usually receives a twig from the fifth cervical nerve, and often one from the third. From the second and third nerves arise the two roots of the descendens cervicalis, whose part in the formation of the ansa hypoglossi has already been seen. The first cervical gives rise to a branch which passes forward deep to the internal jugular vein to join the hypoglossal nerve under cover of the posterior belly of the digastric. The remaining branches of the cervical plexus are small muscular twigs which pass from the second, third, and fourth nerves directly into the longus colli, longus capitis, and scalenus medius, for the supply of those muscles.

Divide the intermediate tendon of the omohyoid muscle and reflect the anterior belly upward. Divide the sternohyoid and sternothyroid muscles just above the manubrium sterni and reflect them upward. Then clean and study the common carotid artery and the vagus nerve, both of which are enclosed in the carotid sheath. (Fig. 5.)

On the right side the common carotid arises behind the sternoclavicular articulation as a branch of the innominate artery. On the left side it arises in the thorax as a branch of the aorta and enters the neck behind the sternoclavicular articulation. Its course in the neck is similar on the two sides, extending from the sternoclavicular articulation upward and somewhat posteriorly, to the level of the upper border of the thyroid cartilage, where it terminates by dividing into internal and external carotids. It has no other branches. Except at its termination it is covered externally by the sternomastoid. It is further covered anteriorly, in the lower part of its course, by the omohyoid, sternothyroid, and sternohyoid muscles. Laterally it is in relation to the internal jugular vein. Medially it is in relation to the trachea, and in the middle portion of its course to the thyroid gland. Posteriorly it rests against the prevertebral muscles (longus colli and longus capitis).

The vagus nerve lies in the most posterior part of the carotid sheath. It is medial to the internal jugular vein and lateral to the internal carotid artery above, and the common carotid below. It passes into the thorax behind the sternoclavicular articulation, lying on the left side between the common carotid artery and the innominate vein, and on the right side between the innominate artery and the innominate vein.

DISSECTION OF THE BACK

For the dissection of the back the body lies prone, with a block elevating the thorax, and the head hanging freely over the end of the table so that the back of the neck is stretched. Certain surface points should be identified before the skin is reflected. In the midline at the base of the skull is the external occipital protuberance. Laterally, behind the lower part of the auricle, is the mastoid process. Arching between the external occipital protuberance and the mastoid on either side, the superior nuchal line may be palpated. In the median line of the back the spinous processes of most of the vertebrae are apparent. The highest vertebral spine which is ordinarily palpable is that of the sixth cervical vertebra. The higher cervical spines are separated from the skin by the ligamentum nuchae, a strong fibrous band which stretches in the median plane from the external occipital protuberance to the seventh cervical spine, and is attached deeply to the spinous processes of all the cervical vertebrae. Below the last lumbar spine, the posterior surface of the sacrum is subcutaneous, and below it, between the buttocks, is the coccyx. Identify also the crest of the ilium, arching laterally from the posterior superior iliac spine. The posterior part of the iliac crest is often covered by a fairly thick layer of subcutaneous fat.

Locate the vertebral border of the scapula. Running laterally and upward from this border the spine of the scapula is subcutaneous throughout its length. It ends in the broad acromion process, which forms the bony prominence of the shoulder.

When these points have been observed make the following incisions through the skin: (1) a median longitudinal incision starting at a point on the back of the skull about half an inch above the external occipital protuberance and ending at the tip of the coccyx; (2) from the upper end of incision one laterally and downward across the back of the skull to the mastoid process; (3) from incision one at the level of the first lumbar spine

upward and laterally to the posterior axillary fold and then along this fold to the back of the arm; (4) from incision one at the level of the seventh cervical spine straight laterally to the tip of the acromion; (5) from the lower end of incision one upward and laterally to the posterior iliac spine, and then along the iliac crest to the mid-axillary line. By these incisions three large flaps of skin will be marked out on each side. These flaps should now all be reflected laterally.

The reflection of skin will expose the superficial fascia of the back. It has no specific characteristics, but resembles the superficial fascia in other parts of the body. It need not be separately removed, but may be reflected together with the deep fascia in cleaning the superficial muscles of the back.

The cutaneous nerves of the back are derived from the posterior rami of the cervical, thoracic, and lumbar spinal nerves. With the exception of the great occipital nerve, they are small, and no special dissection need be undertaken for their display. Some of them will undoubtedly be seen, piercing the superficial muscles of the back in linear series not far lateral to the median line, as these muscles are cleaned.

The most superficial muscles of the back are the trapezius and the latissimus dorsi. Clean the trapezius, by removing in a single layer the superficial and the deep fascia which cover its external surface. As the uppermost part of the muscle is being cleaned, secure the great occipital nerve. This large cutaneous nerve is the terminal part of the posterior ramus of the second cervical nerve. It pierces the trapezius a little below and lateral to the external occipital protuberance and runs upward in the fascia, to be distributed to the back of the scalp. It is accompanied in its distribution by the terminal branches of the occipital artery. (Fig. 6.)

The trapezius is a flat triangular muscle, which arises by a long linear origin from the medial third of the superior nuchal line, the entire length of the ligamentum nuchae, and the spinous processes of all twelve thoracic vertebrae. Its fibres converge laterally to a V-shaped insertion on the posterior border of the lateral third of the clavicle, the medial border of the acromion, and the upper border of the scapular spine.

Clean the latissimus dorsi and the posterior lamella of the lumbodorsal fascia. The deep fascia known as the lumbodorsal fascia differs from the deep fascia ordinarily found surrounding muscles in that the fascia is here resolved into dense aponeurotic sheets. The lumbodorsal fascia is found

The vagus nerve lies in the most posterior part of the carotid sheath. It is medial to the internal jugular vein and lateral to the internal carotid artery above, and the common carotid below. It passes into the thorax behind the sternoclavicular articulation, lying on the left side between the common carotid artery and the innominate vein, and on the right side between the innominate artery and the innominate vein.

DISSECTION OF THE BACK

For the dissection of the back the body lies prone, with a block elevating the thorax, and the head hanging freely over the end of the table so that the back of the neck is stretched. Certain surface points should be identified before the skin is reflected. In the midline at the base of the skull is the external occipital protuberance. Laterally, behind the lower part of the auricle, is the mastoid process. Arching between the external occipital protuberance and the mastoid on either side, the superior nuchal line may be palpated. In the median line of the back the spinous processes of most of the vertebrae are apparent. The highest vertebral spine which is ordinarily palpable is that of the sixth cervical vertebra. The higher cervical spines are separated from the skin by the ligamentum nuchae, a strong fibrous band which stretches in the median plane from the external occipital protuberance to the seventh cervical spine, and is attached deeply to the spinous processes of all the cervical vertebrae. Below the last lumbar spine, the posterior surface of the sacrum is subcutaneous, and below it, between the buttocks, is the coccyx. Identify also the crest of the ilium, arching laterally from the posterior superior iliac spine. The posterior part of the iliac crest is often covered by a fairly thick layer of subcutaneous fat.

Locate the vertebral border of the scapula. Running laterally and upward from this border the spine of the scapula is subcutaneous throughout its length. It ends in the broad acromion process, which forms the bony prominence of the shoulder.

When these points have been observed make the following incisions through the skin: (1) a median longitudinal incision starting at a point on the back of the skull about half an inch above the external occipital protuberance and ending at the tip of the coccyx; (2) from the upper end of incision one laterally and downward across the back of the skull to the mastoid process; (3) from incision one at the level of the first lumbar spine

surface of the muscle by passing across the posterior triangle of the neck. They are accompanied by the ascending branch of the transverse cervical artery. (Fig. 6.)

Clean and study the rhomboid muscles. These two muscles are sometimes more or less fused with one another. The rhomboideus minor is a

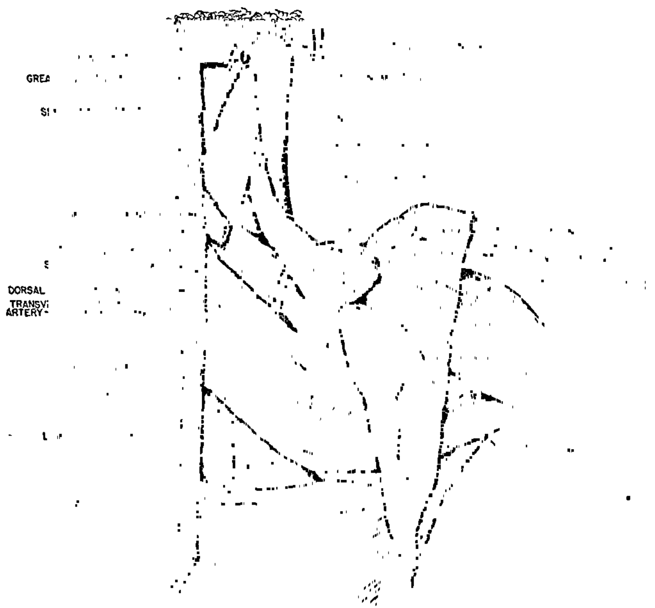

Fig. 6.—Dissection of the upper part of the back, after reflection of the trapezius. A segment of the rhomboideus minor has been removed.

narrow flat muscle taking origin from the lower part of the ligamentum nuchae and the spinous process of the seventh cervical vertebra. Its fibres run downward and laterally to be inserted into the vertebral border of the scapula opposite the scapular spine. The rhomboideus major is a much wider flat muscle immediately below the minor. It takes origin

in the lumbar region of the back disposed in two layers or lamellae, between which the deep muscles of the back are enclosed. The more superficial of these layers (posterior lamella) must be cleaned at the same time as the latissimus dorsi, since the muscle takes origin in part from this layer of fascia. In removing the superficial fascia from the region just lateral to the lumbar vertebral spines, care must be taken to avoid cutting through and removing at the same time the posterior lamella of the lumbodorsal fascia. It may be recognized by the glistening aponeurotic appearance of its external surface. It is attached medially to the lumbar and sacral spines and stretches laterally as a broad aponeurotic sheet.

The latissimus dorsi is a broad flat muscle which covers the lower lateral part of the back. It is overlapped to a slight extent by the lowest part of the trapezius. It has a wide origin from the spinous processes of the lower five or six thoracic vertebrae, the posterior lamella of the lumbodorsal fascia, the outer lip of the posterior half of the iliac crest, and by small pointed slips from the outer surfaces of the lower three or four ribs, where it is in close relation to the lower slips of origin of the external oblique muscle of the abdomen. The fibres converge upward and laterally to a flat tendon which winds around the lower border of the teres major muscle, to be inserted into the intertubercular sulcus of the humerus. The manner of its insertion can not be investigated at present. The upper part of the lateral border of the latissimus dorsi forms the posterior fold of the axilla.

The trapezius should now be reflected. The dissection of the back is very largely a dissection of muscles, and it is essential for the proper display of the deeper layers of muscle, that as each succeeding muscle is reached its external surface be completely cleaned, and that as each muscle is cut and reflected, it be completely reflected back to its bony attachments. Detach the uppermost fibres of the trapezius from the occipital bone and make a longitudinal incision through the trapezius parallel and about an inch lateral to the median line of the body. Reflect the medial segment of the cut muscle medially, and the lateral segment laterally to its insertion. As the lateral segment is turned laterally the nerves and vessels which supply the trapezius will be found ramifying on its deep surface. Clean and study them.

The trapezius is supplied by the accessory nerve, supplemented by some twigs from the third and fourth cervical nerves. These reach the deep

into the external surfaces of the lower four ribs. When the posterior serrate muscles have been studied, they may be removed. As this is done, attempt to identify the small branches of the intercostal nerves which emerge from the intercostal spaces to supply them.

As has been seen, the trapezius derives its main nerve supply from a cranial nerve, the accessory. The other muscles of the back, which so far have been studied, derive their nerve supply from the anterior rami of spinal nerves. The deeper muscles of the back, yet to be displayed, are all supplied by the posterior rami of spinal nerves, and it should be remembered that they are the only muscles in the body which are so supplied.

Clean the splenius muscle. This is a flat muscle which takes origin from the lower half of the ligamentum nuchae and the spines of the seventh cervical and first five or six thoracic vertebrae. Its fibres run upward and laterally, and toward its insertion the muscle becomes separated into two parts. The large upper portion, the splenius capitis, has a linear insertion on the mastoid process and the lateral part of the superior nuchal line. The lower portion, the splenius cervicis, is inserted by two or three tendinous slips into the posterior tubercles of the transverse processes of the upper two or three cervical vertebrae, where it is in close relation to the slips of origin of the levator scapulae. The insertion of the splenius is for the most part covered by the sternomastoid. Between the sternomastoid and the trapezius it is relatively superficial and forms the floor of the upper part of the posterior triangle. Detach the splenius from its origin and reflect both parts to their insertions.

The vertebral groove is occupied by a thick elongated mass of muscle which is known collectively as the sacrospinalis. This muscle mass is thickest in the lower thoracic and lumbar regions. Here it is enclosed between the two lamellae of the lumbodorsal fascia. The posterior lamella of the lumbodorsal fascia has already been exposed. It is attached medially to the lumbar and sacral spines and stretches laterally across the external surface of the sacrospinalis, to become continuous finally with the fascial sheaths of the internal oblique and transversus muscles of the anterior abdominal wall. Superiorly it gradually thins out and in the upper thoracic region can not be recognized as a distinct membranous layer. The anterior lamella is attached medially to the tips of the transverse processes of the lumbar vertebrae and stretches laterally across the anterior or deep surface

from the upper four or five thoracic spines and is inserted into the vertebral border of the scapula below the scapular spine.

Clean the levator scapulae. This is a long flat muscle which arises by four pointed slips from the posterior tubercles of the transverse processes of the upper four cervical vertebrae. It is inserted into the vertebral border of the scapula above the scapular spine. The levator scapulae helps to form the floor of the posterior triangle of the neck. Its origin is covered by the upper part of the sternomastoid, and its insertion by the trapezius.

Divide the levator scapulae at about the middle of its length by an incision at right angles to the direction of its fibres, and reflect the cut ends to their origin and insertion. Cut through both rhomboid muscles by a vertical incision about an inch lateral to their origins and reflect the cut ends. As the scapular ends of the three cut muscles are being reflected, find and clean the dorsal scapular nerve and the descending branch of the transverse cervical artery. This nerve and artery leave the posterior triangle at the anterior border of the levator scapulae and descend together in a line slightly medial to the vertebral border of the scapula and deep to the levator scapulae and the two rhomboids. The dorsal scapular nerve is the nerve of supply for the rhomboids.

Cut through the latissimus dorsi by a diagonal incision running from its upper border at a point just medial to the inferior angle of the scapula *downward and laterally, to reach its lateral border at about the level of* the eighth rib. Turn the lateral segment laterally and observe that the muscle is much thicker as it converges toward its insertion than it is near its origin. The broad flat medial segment of the cut muscle should now be cut completely away from its origin and discarded.

Clean the posterior serrate muscles. These are two thin flat muscles which are often more tendinous than muscular. The serratus posterior superior is subjacent to the rhomboids and its fibres run in the same direction as do those of the rhomboids. It arises from the lower part of the ligamentum nuchae and the spines of the seventh cervical and the upper two or three thoracic vertebrae, and is inserted by four slips into the external surfaces of the second, third, fourth, and fifth ribs. The serratus posterior inferior is covered externally by the latissimus dorsi. It arises from the posterior lamella of the lumbodorsal fascia in the region of the lower thoracic and upper lumbar vertebrae. Its fibres run upward and laterally to be inserted

The iliocostalis lumborum arises from the common origin and is inserted by a series of slips into the lower six or seven ribs at their angles. The iliocostalis dorsi receives additional slips of origin from the lower six ribs just medial to their angles, and is inserted into the angles of the upper six ribs. The iliocostalis cervicis receives slips of origin from the upper ribs, and is inserted into the transverse processes of the lower three or four cervical vertebrae. The slips of insertion of the iliocostalis can be seen while the muscle is in position, but the slips of origin are covered by the main mass of the muscle. They may be exposed by rolling the entire muscle laterally. It should be noted that there is no actual structural separation between the three parts of the iliocostalis; the subdivision is an arbitrary matter of anatomical nomenclature.

The longissimus is similarly subdivided for purposes of anatomical description into three parts. These are from below upward the longissimus dorsi, the longissimus cervicis, and the longissimus capitis. The longissimus dorsi arises at the common origin of the sacrospinalis and is inserted by means of two long series of muscular slips. The more lateral series is inserted into the transverse processes of the lumbar vertebrae, and into the lower ten ribs lateral to their tubercles; the more medial series is inserted into the accessory tubercles of the lumbar vertebrae and the tips of the transverse processes of the thoracic vertebrae. The longissimus cervicis receives slips of origin from the transverse processes of the upper thoracic vertebrae and is inserted into the posterior tubercles of the transverse processes of the second to the sixth cervical vertebrae. The longissimus capitis arises from the transverse processes of the upper three or four thoracic vertebrae and the articular processes of the lower cervical vertebrae. As its fibres pass upward they form a narrow band-like muscle which is inserted into the posterior part of the mastoid process under cover of the splenius capitis and sternomastoid muscles.

The spinalis is much the smaller of the three parts of the sacrospinalis. Its fibres run upward from the upper lumbar and lower thoracic spinous processes, to be inserted into the spinous processes of a variable number of the upper thoracic vertebrae.

Divide the longissimus capitis about an inch below its insertion, reflect the upper segment back to the insertion, and identify the occipital artery. This vessel ordinarily crosses the deep surface of the longissimus capitis just

of the sacrospinalis. For its display, the following dissection should be undertaken.

Make a longitudinal incision through the posterior lamella, parallel and about half an inch lateral to the median line, from the level of the first lumbar spine to that of the fourth. From either end of this incision carry a horizontal incision laterally for about an inch and a half. The rectangular flap of fascia thus marked out should be turned laterally to expose the posterior surface of the lumbar part of the sacrospinalis. If the sacrospinalis is now pushed medially, the anterior lamella of the lumbodorsal fascia will be exposed. Push the fingers medially, in front of the sacrospinalis, across the exposed surface of the anterior lamella, and observe that this layer of the fascia is attached medially to the transverse processes of the lumbar vertebrae, which also lie anterior to the sacrospinalis. Observe also that the anterior and the posterior lamellae of the fascia fuse with one another along the lateral border of the sacrospinalis. It is this lateral fused portion of the lumbodorsal fascia which comes into relation with the muscles of the anterior abdominal wall. Finally make a short longitudinal incision through the exposed portion of the anterior lamella. If the lips of this incision are spread apart the posterior surface of the quadratus lumborum muscle will be exposed. This is a muscle in the posterior wall of the abdominal cavity.

Clean and study the sacrospinalis. Inferiorly the entire mass has a common large fleshy origin from the spines of all the lumbar vertebrae, from the dorsum of the sacrum, the posterior sacro-iliac ligament, and the most posterior part of the iliac crest, and from the deep surface of the lowest part of the posterior lamella of the lumbodorsal fascia. As the fibres pass upward from their origin, the muscle becomes separated into three parallel longitudinal columns. The most lateral column is known as the iliocostalis, the middle one as the longissimus, and the smallest and most medial is the spinalis. A detailed dissection of each slip and subdivision of the sacrospinalis is not essential, but sufficient cleaning and study should be done to demonstrate the following facts.

The line of division between the iliocostalis and the longissimus is indicated by the line along which the posterior cutaneous nerves emerge. The iliocostalis is subdivided from below upward into three parts; the iliocostalis lumborum, the iliocostalis dorsi, and the iliocostalis cervicis.

spines will be held together by the ligamenta flava and the interspinous ligaments, and may be removed in one piece. Cut through the laminae on each side with a saw. The saw-cut should lie just medial to the articular processes and must be directed obliquely, the saw being held so that it slants medially. In the lumbar region it may be necessary to complete the work of the saw with a mallet and chisel. In dealing with the sacrum remember that the posterior wall of the sacral canal is very thin and that it is desired only to remove this wall, and *not* to cut through the body of the sacrum.

When the vertebral canal is opened, a narrow space loosely filled with fat will be exposed, which lies between the periosteum of the vertebrae and the dura mater of the spinal cord. In the fat of this space are the spinal arteries and the internal vertebral venous plexus. The spinal arteries are a paired series of minute vessels which enter the canal at the intervetrabral foramina. The venous plexus is drained by small spinal veins, which leave the canal through the intervertebral foramina. Neither veins nor arteries can be well demonstrated in the ordinary dissecting room subject.

Clean the external surface of the dura mater spinalis, by removing the fat and the venous plexus. The dura mater is the most external, and the strongest, of the three coverings (meninges) of the spinal cord. At the foramen magnum it is firmly bound to the occipital bone and becomes continuous with the inner layer of the cranial dura. In the vertebral canal, as now exposed, it lies loosely and takes the form of a fibrous tube. At about the level of the second piece of the sacrum it contracts to a filament, the coccygeal ligament, which extends downward through the sacral canal to be attached to the dorsum of the coccyx. Observe the series of lateral prolongations of the dura, which pass into the intervertebral foramina; within these are enclosed the roots of the spinal nerves.

Open the dura by a longitudinal incision along is entire length and expose the arachnoid. This is the second of the spinal coverings. It is a thin, delicate membrane, of gauzy texture. At the foramen magnum it is continuous with the cranial arachnoid; inferiorly it extends as far as does the dura and ends by joining the filum terminale, the thread which forms the core of the coccygeal ligament. The arachnoid also shows a series of lateral prolongations, which surround the roots of the spinal nerves, and which blend with the dura in the intervertebral foramina. Between the dura and the arachnoid is a narrow interval, the subdural space, which contains in life

below its insertion. Occasionally it crosses the longissimus superficially. The occipital artery arises from the external cartotid in the anterior triangle of the neck. Emerging from the deep surface of the mastoid process, it will now be seen running medially and upward, in the interval between the splenius and semispinalis muscles. Near the medial border of the upper part of the splenius it becomes superficial by piercing the trapezius, or by winding around the lateral border of that muscle. It is distributed to the back of the scalp, in company with the greater occipital nerve.

Clean the semispinalis capitis, which has been exposed by the reflection of the trapezius and splenius. This is a large muscle which takes origin by a series of tendinous slips from the articular processes of the fourth, fifth, and sixth cervical vertebrae and the transverse processes of the first five or six thoracic vertebrae. It has a thick, fleshy insertion into the *occipital bone* between the superior and inferior nuchal lines just lateral to the external occipital crest. Observe that the semispinalis is pierced by the greater occipital nerve, and that in the cervical region the semispinales of the two sides are separated from each other only by the ligamentum nuchae.

The deepest muscles of the back are several groups of numerous small muscular slips which connect the various individual vertebrae with each other. Those are the semispinalis cervicis, semispinalis dorsi, multifidus, rotatores, interspinales, and intertransversarii. The beginner may be forgiven for neglecting to dissect them at all, and for troubling his memory with them only so far as to remember that they exist. Under cover of the upper parts of the splenius and semispinalis capitis is a group of small sub-occipital muscles which may be treated in the same way.

THE VERTEBRAL CANAL

Preparatory to opening the vertebral canal the laminae and spinous processes of the vertebrae must be cleaned as completely as possible. This is done by removing the muscles which fill the vertebral groove on each side. In doing this retain a few of the posterior rami of the thoracic nerves, so that they may later be traced to the main trunk of the nerves from which they arise. The vertebral canal is then to be opened by removal of the entire series of the laminae and spinous processes, from the level of the fourth cervical vertebra down to the sacrum. The successive laminae and

spinal ganglion. These ganglia, with the exception of those of the sacral nerves, are also situated within the intervertebral foramina.

The length of the spinal nerve roots increases steadily from above downward, as a necessary consequence of the fact that the length of the cord is so much less than is that of the vertebral canal. Observe that the cervical roots pass almost directly laterally to reach the intervertebral foramina, while in the thoracic region the roots take a course of constantly increasing obliquity, downward and laterally. The lumbar and sacral roots, which arise in close succession from the lower part of the cord, pass almost vertically downward through the subarachnoid space in a brush-like aggregation of filaments which is known as the cauda equina.

With the bone forceps chip away the articular processes forming the posterior boundary of one or two of the intervertebral foramina in the thoracic region, to expose the spinal ganglion and the trunk of the spinal nerve. The nerve trunk and the ganglion are enclosed in a prolongation of the dura mater, which must be carefully cleared away. Observe that the trunk of the spinal nerve is very short, as each divides almost at once into an anterior and a posterior ramus. In nearly all cases the anterior ramus is much the larger. The posterior ramus passes directly backward through the deep muscles of the back. The anterior ramus passes laterally. The anterior rami of the thoracic nerves are the intercostal nerves; the anterior rami of the cervical, lumbar, and sacral nerves take part in the formation of the cervical, brachial, lumbar, and sacral plexuses.

STERNOCLAVICULAR ARTICULATION

The sternoclavicular articulation is the diarthrodial joint at which the medial end of the clavicle meets the clavicular notch of the manubrium sterni and the upper border of the first costal cartilage. It is surrounded by a strong fibrous capsule, whose anterior surface should now be cleaned. The anterior portion of the fibrous capsule is known as the anterior sternoclavicular ligament. Detach the subclavius muscle from its origin on the first rib and clean the costoclavicular ligament. This is a strong band of fibres running upward and laterally from the first rib to the costal tubercle on the inferior surface of the clavicle. Cut through the entire circumference of the capsule close to the sternum, to detach the clavicle. Observe that the fibres forming the posterior part of the capsule (posterior sternoclavicular

a watery fluid similar to lymph. The subdural space is traversed by filamentous strands by which the arachnoid is loosely attached to the inner surface of the dura.

Slit the arachnoid longitudinally, to expose the pia mater, the spinal cord, and the roots of the spinal nerves. The pia is the innermost of the three meninges. It is a delicate membrane which closely invests the outer surface of the spinal cord and the roots of the nerves, from which it can not readily be separated. It is best regarded as an integral part of the spinal cord. The subarachnoid space is more capacious than is the subdural space, particularly in the lumbar region, where it encloses the great group of lumbar and sacral nerve roots known as the cauda equina. The subarachnoid space contains the cerebro-spinal fluid.

Study the external form of the spinal cord. The spinal cord (medulla spinalis) begins at the foramen magnum, above which it is directly continuous with the medulla oblongata of the brain, and ends at about the level of the lower border of the first lumbar vertebra. The tapering inferior end of the cord, from which the sacral nerve roots arise, is known as the conus medullaris. From the tip of the conus a thread-like structure, the filum terminale, is continued downward through the subarachnoid space; below the termination of the dura the filum terminale is enclosed within the coccygeal ligament. Observe that the diameter of the spinal cord is not the same throughout, but is greatest in the lower cervical region, where it exhibits the cervical enlargement, and in the lower thoracic region, where it exhibits the lumbar enlargement. This is due to the large size of the lower cervical and the lumbar nerves, which arise from these two regions.

From the spinal cord arise, each by two roots, eight pairs of cervical nerves, twelve pairs of thoracic nerves, five pairs of lumbar nerves, five pairs of sacral nerves, and one pair of coccygeal nerves. The posterior roots are made up of afferent (sensory) nerve fibres, and arise from the postero-lateral sulcus on the posterior aspect of the cord. The anterior roots are made up of efferent (motor) nerve fibres and arise from the antero-lateral sulcus, on the anterior aspect of the cord. It should be observed that each root does not arise as a single structure, but as a linear series of filaments, which unite to form a single root. The two roots of each nerve remain distinct within the vertebral canal and unite only upon reaching the intervertebral foramina. On each posterior root, just proximal to the point of union, is a swelling, the

THE ROOT OF THE NECK

The subclavian artery lies deeply in the root of the neck. On the right side this vessel arises behind the sternoclavicular articulation as one of the terminal branches of the innominate artery; on the left side it arises in the thorax as a branch of the aorta and enters the neck behind the sternoclavicular articulation, where it lies behind and slightly lateral to the common carotid. The further course of the artery does not differ on the two sides. The subclavian artery in the neck is divided for descriptive purposes into three parts. Since this subdivision is based on the relation of the artery to the scalenus anterior, it is best first to clean and study that muscle.

FIG. 8.—Deep dissection of the root of the neck. The scalenus anterior and the thyroid gland have been removed on the right side.

The scalenus anterior arises by a series of slips from the anterior tubercles of the transverse processes of the third, fourth, fifth, and sixth cervical vertebrae. Descending under cover of the sternomastoid, its fibres narrow to a tendinous insertion on the scalene tubercle on the upper surface of the first rib. Its anterior surface is crossed from above downward and medially by the phrenic nerve. Parallel to the phrenic but somewhat more medial, the ascending cervical artery will be found on the anterior surface of the muscle. At its insertion, the scalenus anterior is crossed anteriorly by the subclavian vein, and at a slightly higher level by the transverse cervical and transverse scapular arteries. (Figs. 7 and 8.)

The first part of the subclavian artery extends from a point behind the sternoclavicular articulation upward and laterally to the medial border of the scalenus anterior; the second part runs laterally, behind the scalenus

ligament) are thicker and tougher than are the anterior ones, and that the capsule is posteriorly in close relation to the origins of the sternohyoid and sternothyroid muscles. Note also that the interior of the joint is separated into two distinct cavities by an articular disc of fibro-cartilage, which intervenes between the clavicle and the first rib and sternum.

Now saw through the clavicle at about its middle and discard the medial half. *By this means the continuity of the posterior triangle with the axilla* is clearly revealed and the brachial plexus may be reviewed in its entirety. (Fig. 7.)

FIG 7.—Complete dissection of the brachial plexus. The medial end of the clavicle has been removed, and both pectoral muscles reflected.

When review of the brachial plexus is completed, the superior extremity, together with its girdle, should be removed from the trunk. The muscles attaching the girdle to the trunk posteriorly have already been cut in the dissection of the back. Now divide the serratus anterior by a vertical incision at about the midaxillary line. Sever the three trunks of the brachial plexus, the first part of the axillary artery, and the axillary vein. The upper trunk of the plexus should be cut proximal to the origin of the suprascapular nerve. When those structures have been severed, the limb will be attached to the trunk only by strands of areolar tissue, which can easily be cut or torn away.

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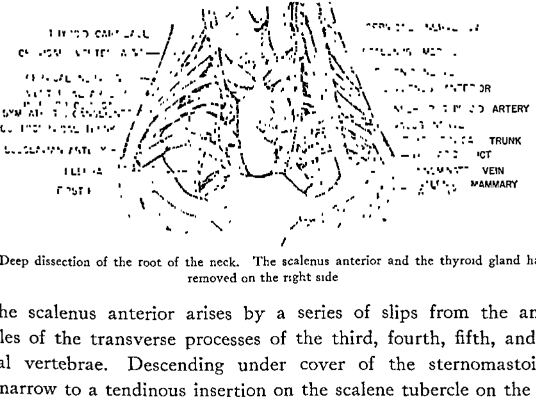

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The first part of the subclavian artery extends from a point behind the sternoclavicular articulation upward and laterally to the medial border of the scalenus anterior; the second part runs laterally, behind the scalenus

anterior; the third part runs laterally and slightly downward from the lateral border of the scalenus anterior to the outer border of the first rib, where it becomes the axillary artery.

Clean and study the first part of the subclavian and the branches which arise from it. Observe that in this part of its course the artery is covered anteriorly by the clavicle and the sternomastoid, and is crossed from above downward by the phrenic and vagus nerves and the vertebral vein. On the left side it is also crossed anteriorly by the terminal part of the thoracic duct. The thoracic duct emerges from behind the left common carotid artery at about the level of the lower border of the thyroid gland and runs laterally and downward, passing behind the vagus nerve and in front of the subclavian artery, to join the terminal part of the internal jugular or the subclavian vein, or the beginning of the innominate vein. (Fig. 8.)

The first branch of the subclavian is the vertebral artery. This vessel ascends almost vertically to enter the costotransverse foramen of the sixth cervical vertebra behind the most lateral part of the longus colli muscle. The vertebral vein descends in front of the vertebral and subclavian arteries, to join the innominate vein; it is frequently very large and may obscure the dissection of the arteries, in which case it should be removed.

Slightly more laterally the thyrocervical trunk and the internal mammary artery arise from the first part of the subclavian. The thyrocervical trunk runs upward for a short distance and ends by dividing into the transverse cervical, the transverse scapular, and the inferior thyroid arteries. The former two vessels pass laterally across the scalenus anterior. The inferior thyroid may be regarded as the main continuation of the thyrocervical trunk. It continues to ascend, and then bends medially and downward, passing in front of the vertebral artery and behind the common carotid and the vagus, to reach the thyroid gland. Near its origin the inferior thyroid gives rise to the ascending cervical artery, a small but constant branch which ascends on the scalenus anterior. The internal mammary artery runs downward and forward from the subclavian, to reach the anterior thoracic wall behind the first costal cartilage. Near its origin it comes into relation with the phrenic nerve, which may cross it either anteriorly or posteriorly.

Detach the scalenus anterior from its insertion and turn it upward, to expose the second part of the subclavian. Observe that both the first and

second parts of the subclavian rest inferiorly and posteriorly against the pleura, by which they are separated from the lung. The apices of the pleura and lung rise for a considerable distance above the first rib on each side, into the root of the neck. The only branch of the second part of the subclavian is the costocervical trunk. This vessel runs upward and posteriorly across the pleura, and terminates by dividing into the deep cervical and superior intercostal arteries. The former ascends behind the scalenus medius to reach the deep muscles at the back of the neck. The superior intercostal descends on the posterior thoracic wall.

The third part of the subclavian artery rests upon the upper surface of the first rib and is in relation posteriorly to the scalenus medius and the lower trunk of the brachial plexus. It usually has no branches, but occasionally gives rise to the transverse cervical or the transverse scapular artery, or both.

Remove the remnants of the infra-hyoid muscles and study the thyroid gland, trachea, and oesophagus. The thyroid gland is a bilobed organ which lies in relation to the front and sides of the upper part of the trachea. It consists of two lateral lobes and a much smaller median connecting portion, the isthmus, which crosses the front of the trachea. The greatest extent of the lateral lobes is superiorly, where they may reach as high as the middle of the thyroid cartilage. Anterolaterally the gland is covered by the infra-hyoid muscles; postero-laterally it is in relation to the common carotid artery. In the median line the isthmus is covered externally only by skin and fascia and may be palpated from the surface.

Observe the extensive blood supply of the thyroid gland. It is provided by the superior and inferior thyroid arteries, which anastomose freely with each other and with their fellows of the opposite side. The blood is drained from the gland by the superior and inferior thyroid veins. The inferior thyroid vein does not accompany the artery, but descends in front of the trachea to enter the thorax. It may be single or paired. There is frequently present a middle thyroid vein, which passes laterally into the internal jugular vein.

Sever the thyroid vessels close to the gland and remove the gland. Study its posterior surface and attempt to identify the parathyroid glands. There are two pairs of these, a superior and an inferior. They are small flattened oval bodies, closely applied to the posterior surfaces of the lateral

lobes of the thyroid, and sometimes embedded within the thyroid substance. They may frequently be distinguished from the thyroid by their lighter color.

The trachea is a median tubular organ, which begins at the lower border of the cricoid cartilage. The latter is one of the cartilages of the larynx; its anterior arch may be seen a short distance below the thyroid cartilage, to which it is attached by means of the cricothyroid membrane and the cricothyroid muscle. From the cricoid cartilage the trachea descends through the lower part of the neck into the thorax. Its lumen is kept permanently open by a series of cartilaginous rings in its wall. Observe that these rings are incomplete posteriorly, where the trachea rests against the anterior surface of the oesophagus.

Only a very incomplete view of the oesophagus may be obtained while the trachea is still in place. The oesophagus is a hollow organ which begins at the level of the lower border of the cricoid cartilage, as a direct continuation of the pharynx, and descends into the thorax. It lies immediately behind the trachea and in front of the bodies of the vertebrae and the prevertebral muscles. It is flattened from before backward, its lumen being open only when food is passing through it.

Dissect in the groove between the oesophagus and the trachea and expose the recurrent (inferior laryngeal) nerve, which ascends in this groove to reach the larynx. The origin of the left recurrent as a branch of the left vagus is within the thoracic cavity and can not be seen at present. The right recurrent arises from the right vagus as the latter nerve crosses the subclavian artery. From its point of origin the right recurrent turns medially and upward, passing behind the beginnings of the right subclavian and common carotid arteries, to reach the interval between the oesophagus and the trachea.

THE FACE

The surface features of the face are those with which the dissector is for the most part already thoroughly familiar. The mental protuberance, the lower border and the angle of the mandible are readily palpable through the skin. The prominence of the cheek is formed by the zygomatic bone, which extends posteriorly to join the zygomatic process of the temporal bone in the formation of the zygomatic arch, also subcutaneous. The lips are covered

with a mucous membrane, which is continuous externally with the skin of the face and internally with the mucous membrane lining the mouth. At the nostrils the skin of the face is continuous with the mucous lining of the nasal cavities. The free margins of the upper and lower eyelids form together a slit-like orifice known as the rima palpebrarum. At the rima the skin of the face is continuous with the conjunctiva. The conjunctiva is a delicate membrane which forms the inner linings of both eyelids and is further reflected over the anterior part of the eyeball, the conjunctiva as a whole enclosing a space, open to the exterior at the rima palpebrarum, and known as the conjunctival sac. The conjunctival sac lies between the inner surfaces of the eyelids and the anterior surface of the eyeball. In the free margin of each eyelid, close to its medial end, is a small opening at the summit of a slight elevation. The elevation is the papilla lacrimalis, and the opening the puncta lacrimalis. It marks the beginning of the lacrimal duct, which conveys the tears from the conjunctival sac.

Before reflecting the skin from the face stitch the eyelids together. Distend the cheeks slightly by stuffing the mouth with cheese-cloth or cotton, and stitch the lips together. Then make the following incisions through the skin: (1) a median longitudinal incision starting at the crown of the head and running downward across the forehead, along the bridge of the nose, and ending at the mental protuberance; (2) a transverse incision starting from the first incision at the level of the rima palpebrarum, and running laterally and backward to a point just in front of the external auditory meatus. This incision must bifurcate in the region of the upper and lower eyelids, so that it will pass through the skin of each lid, just above and below the rima; (3) a transverse incision running from the angle of the mouth laterally and backward to the posterior border of the ramus of the mandible. From the angle of the mouth this same incision should be extended medially as a bifurcate incision reaching to incision one along the red margins of the upper and lower lips; (4) a transverse incision along the lower border of the mandible, from the symphysis to a point slightly behind the angle. By this means three flaps of skin will be mapped out, which should all be reflected laterally and backward from the median line. Some difficulty will be met in reflecting the skin of the face, since the superficial muscles of the face are inserted for the most part into the skin; the strands of these muscles should be cut away from the deep surface of the skin and the skin reflected cleanly.

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covering the vertex of the skull, and are inserted into the skin of the eyebrows and the root of the nose, blending to some extent with the upper part of the orbicularis oculi.

The nasalis is a small muscle which arises at the side of the bridge of the nose and runs downward and laterally to be inserted in the skin at the junction of the wing of the nose and the cheek.

The orbicularis oris surrounds the opening of the mouth and is the main intrinsic muscle of the lips. Its fibres are derived largely from the other superficial muscles yet to be observed, and are inserted both into the skin covering the lips externally and into the mucous membrane lining the lips internally.

The quadratus labii superioris arises by three heads, a zygomatic head from the lowest part of the external surface of the zygomatic bone, an infra-orbital head from the infra-orbital margin of the maxilla, and an angular head from the root of the nose. The fibres of the three heads converge toward the upper lip, into the skin of which they are inserted, many of them joining the orbicularis oris.

The zygomaticus is a flat, band-like muscle arising from the external surface of the zygomatic bone lateral to the origin of the zygomatic head of the quadratus labii superioris, and passing to the angle of the mouth.

The risorius is a purely superficial muscle arising from the superficial fascia over the parotid gland. It passes forward across the cheek to the angle of the mouth, where it blends with the orbicularis oris.

The triangularis arises from the lower part of the external surface of the anterior half of the mandible, and converges upward toward the angle of the mouth, where it is in part inserted directly into the skin and in part joins the orbicularis oris.

The quadratus labii inferioris arises from the external surface of the mandible below the canine and premolar teeth and runs upward and medially into the orbicularis oris.

The platysma lies for the most part in the neck. Its more posterior fibres, however, run upward across the mandible, behind the triangularis, and blend with the triangularis, the risorius, and the orbicularis oris.

The muscles just described, as well as the deeper muscles of the same group, are all supplied by branches of the facial nerve. Since these branches enter the deep surfaces of the muscles they will not have been injured if the

In the temporal region the superficial temporal vessels lie immediately subadjacent to the skin and will be reflected with it if care is not taken.

The superficial muscles of the face belong to the general group known as the muscles of facial expression. These muscles for the most part take origin on one of the bones of the face and are inserted into the skin and superficial fascia. They are difficult of satisfactory demonstration in the ordinary dissecting room subject, since they are embedded in the superficial fascia, which must be removed from them with considerable care. The

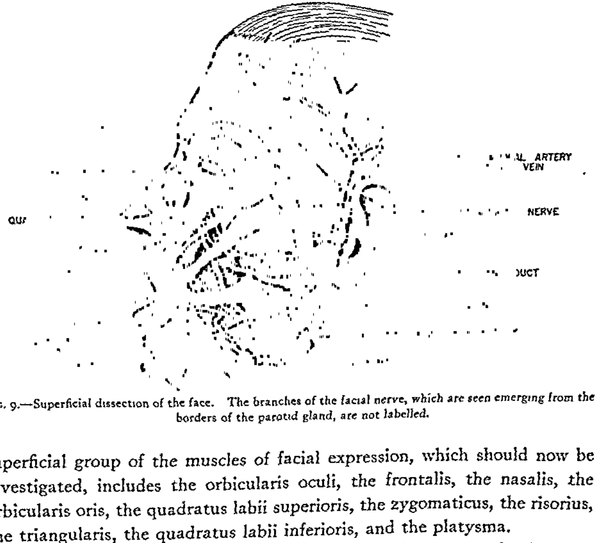

Fig. 9.—Superficial dissection of the face. The branches of the facial nerve, which are seen emerging from the borders of the parotid gland, are not labelled.

superficial group of the muscles of facial expression, which should now be investigated, includes the orbicularis oculi, the frontalis, the nasalis, the orbicularis oris, the quadratus labii superioris, the zygomaticus, the risorius, the triangularis, the quadratus labii inferioris, and the platysma.

The orbicularis oculi is a circular muscle which surrounds the rima palpebrarum. Its fibres lie just beneath the skin in the upper and lower eyelids, but it is more extensive than the lids and covers also the bony rim of the orbit, from which some of its fibres take origin.

The frontalis is a thin flat muscle which lines just under the skin of the forehead. Its fibres arise from the galea aponeurotica, the aponeurosis

descends into the neck below the angle of the mandible, to supply the platysma.

The substance of the parotid gland should now be carefully cut away, a bit at a time, to expose the structures which are embedded in it. These are the trunk of the facial nerve and the beginning of its branches, the terminal part of the external carotid artery, and the posterior facial vein. Deeply the parotid is in relation to the styloid process and the origin of the stylohyoid

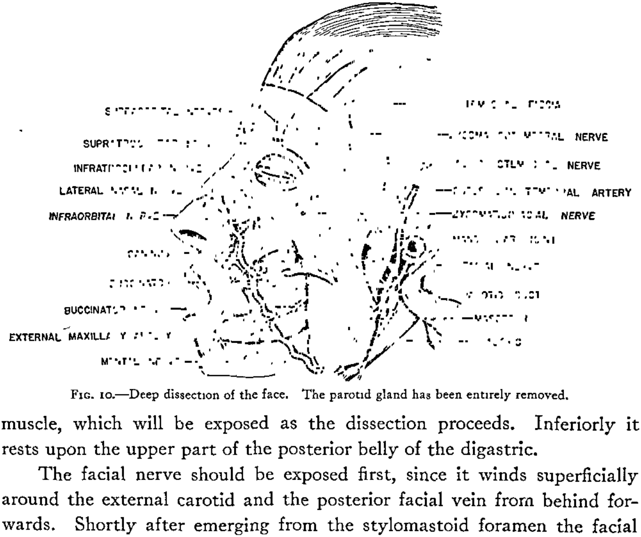

FIG. 10.—Deep dissection of the face. The parotid gland has been entirely removed.

muscle, which will be exposed as the dissection proceeds. Inferiorly it rests upon the upper part of the posterior belly of the digastric.

The facial nerve should be exposed first, since it winds superficially around the external carotid and the posterior facial vein from behind forwards. Shortly after emerging from the stylomastoid foramen the facial gives rise to a small posterior auricular branch which passes upward and backward on the external surface of the mastoid process, to supply the posterior auricular and occipitalis muscles. Just below this the trunk gives off a branch which descends deeply to supply the stylohyoid and the posterior belly of the digastric. The trunk of the facial, still within the substance of the parotid, then usually divides into two trunks, an upper and a lower. From the upper trunk arise temporal, zygomatic, and buccal branches; from the lower trunk buccal, mandibular, and cervical branches. (Fig. 10.)

dissection has been carefully done. Attempt now to demonstrate the branches of distribution of the facial nerve on the face.

As the trunk of the facial nerve emerges from the stylomastoid foramen it passes directly into the parotid gland. Within the substance of the gland it breaks up into numerous branches which emerge separately onto the face from under cover of the superior and anterior borders of the parotid. For this reason it is best first carefully to clean the external surface of the parotid, and to identify the branches of the facial nerve as the borders of the gland are cleaned. (Fig. 9.)

The parotid gland occupies the interval between the posterior border of the ramus of the mandible and the anterior border of the sternomastoid muscle and mastoid process. A flattened portion is also prolonged forward over the external surface of the ramus of the mandible and posterior part of the masseter muscle. The duct of the parotid is usually of considerable size: It emerges from the anterior border of the gland and crosses the cheek anteriorly about half an inch below the zygomatic arch. It pierces the middle of the cheek to open into the cavity of the mouth. The parotid gland is enclosed in a sheath of fairly dense fascia which is continuous anteriorly with the deep fascia covering the external surface of the masseter muscle. This fascia must be removed from the external surface of the parotid, but not at present from the masseter.

Emerging from under cover of the superior border of the gland will be found the temporal and zygomatic branches of the facial nerve. The temporal branch runs upward over the temporal fascia, to be distributed to the auricularis superior and anterior (two small, unimportant muscles of the external ear) and to the frontalis. The zygomatic branch runs upward and forward across the zygomatic bone to reach the orbicularis oculi.

Emerging from under cover of the anterior border of the parotid are the buccal and mandibular branches of the facial nerve. The buccal branches, of which there are usually two or three, pass forward across the cheek, to supply the zygomaticus, quadratus labii superioris, nasalis, orbicularis oris, risorius, caninus, and buccinator. The mandibular branch passes forward just above the lower border of the mandible, to reach the triangularis and quadratus labii inferioris. The various branches of the facial, particularly the buccal and mandibular branches, usually communicate with one another on the face by small anastomosing loops. The cervical branch of the facial

descends into the neck below the angle of the mandible, to supply the platysma.

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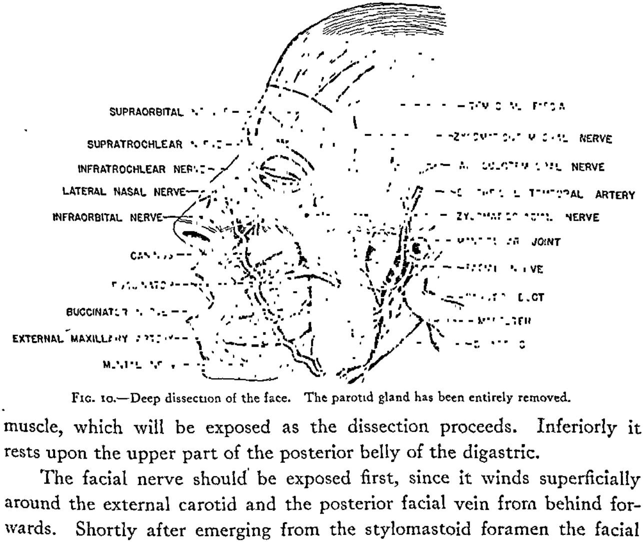

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The posterior facial vein is formed in the region of the root of the zygomatic arch by the union of superficial temporal and middle temporal veins. It descends through the substance of the parotid, usually crosses the digastric superficially, and terminates at about the level of the angle of the mandible by dividing into two branches, one of which usually passes forward to join the anterior facial in the common facial, the other crossing the sternomastoid to join the external jugular vein. It lies superficial to the external carotid artery, and may be removed, if desired, in cleaning the artery.

Ascending from the carotid triangle of the neck deep to the stylohoid and the posterior belly of the digastric, the *external carotid artery* becomes embedded in the deepest part of the parotid gland, where it is crossed externally by the facial nerve. It ascends behind the posterior border of the ramus of the mandible and terminates behind the neck of the mandible by dividing into the internal maxillary and superficial temporal arteries. Deeply it is in relation to the styloid process, which separates it from the internal carotid artery. Just above the posterior belly of the digastric it gives rise to a small posterior auricular branch, which accompanies the posterior auricular branch of the facial nerve across the external surface of the mastoid process.

Only the beginning of the internal maxillary artery can be exposed at present. It passes forward and medially, deep to the neck of the mandible, to enter the infratemporal fossa.

Clean the superficial temporal artery, securing at the same time the auriculotemporal nerve. The superficial temporal artery ascends immediately in front of the ear, and at about the level of the upper tip of the auricle divides into frontal and parietal branches, which ramify in the scalp over the frontal and parietal bones. Near its origin it gives rise to the transverse facial artery, which passes forward across the face just above the parotid duct. At a slightly higher level the superficial temporal gives rise to the middle temporal artery, which runs forward, to pierce the temporal fascia, and enter the temporal muscle.

The auriculo-temporal nerve is a cutaneous nerve derived from the mandibular division of the trigeminal. It emerges on the face from behind the condyle of the mandible and turns upward, in close relation to the superficial temporal artery, to be distributed to the skin of the upper part of the auricle and the greater part of the temporal region. (Figs. 9 and 10.)

Study the external maxillary artery. This vessel reaches the face by winding over the lower border of the mandible about three-quarters of an inch in front of the angle. From this point it passes upward and forward across the face, pursuing a somewhat tortuous course, to the medial angle of the eye, where its terminal portion is known as the angular artery. In its course across the face it usually passes deep to the risorious, zygomaticus, and quadratus labii superioris, which may be divided to expose the artery. From its anterior aspect the external maxillary gives rise to superior and inferior labial arteries, which run forward and medially in the substance of the upper and lower lips, to anastomose with their fellows of the opposite side, and to a lateral nasal branch to the side of the nose. From its posterior aspect arise irregular branches to the skin and muscles of the cheek.

Clean the masseter muscle. This is a thick, quadrilateral muscle belonging to the group known as the muscles of mastication, which covers the ramus of the mandible externally. It arises from the lower border and internal surface of the zygomatic arch, and is inserted on the external surface of the ramus and of the body of the mandible near the angle. It is crossed externally by the transverse facial vessels, the parotid duct, and the buccal and mandibular branches of the facial nerve. Push the posterior border of the masseter forward, and attempt to identify the nerve of supply, which crosses the mandibular notch to enter the deep surface of the muscle. It is derived from the mandibular division of the trigeminal nerve.

The cutaneous nerves of the face are all derived from the trigeminal or fifth cranial nerve. The three divisions of this nerve are the ophthalmic, maxillary, and mandibular nerves, and cutaneous branches of each of these appear on the face. Their terminal ramifications are of course superficial, since they reach the skin, but the main trunks, which should now be exposed, enter the face deeply, most of them emerging from foramina in the facial bones. In exposing the nerves, the various superficial muscles of facial expression which cover them should be reflected or removed. (Fig. 10.)

The cutaneous branches of the ophthalmic nerve are the supraorbital, supratrochlear, infratrochlear, and external nasal nerves. The largest of these is the supraorbital. It leaves the orbit at the supraorbital notch or foramen, and passes upward on the frontal bone under cover of the frontalis muscle. Its branches of distribution pierce the frontalis to supply the skin of the forehead. The supratrochlear nerve is small; it emerges from the upper

medial angle of the orbit, under cover of the frontalis and the orbicularis oculi, to supply the skin in the region of the glabella. The infratrochlear nerve, also small, appears on the face just above the medial angle of the eye, and supplies the skin of the eyelids and the upper part of the side of the nose. The external nasal nerve emerges between the nasal bone and the nasal cartilage and supplies the skin of the bridge of the nose.

The cutaneous branches of the maxillary nerve are the infraorbital, zygomatico-facial, and zygomatico-temporal nerves. The infraorbital is the terminal part of the maxillary nerve proper. It emerges from the infraorbital foramen and breaks up, under cover of the infraorbital head of the quadratus labii superioris, into a number of branches which supply the skin of the upper lip, the wing of the nose, and the upper part of the cheek. The zygomatico-facial nerve emerges through a small foramen in the zygomatic bone, to supply the skin over the malar prominence. The zygomatico-temporal is a minute nerve which pierces the temporal fascia, to supply a small area of skin in the anterior part of the temporal region.

The cutaneous branches of the mandibular nerve are the auriculo-temporal, the buccinator, and the mental nerves. The auriculo-temporal nerve has already been exposed. The buccinator nerve emerges from under cover of the anterior border of the masseter and runs downward and forward to supply the skin of the lower part of the cheek. The mental nerve emerges from the mental foramen of the mandible, under cover of the triangularis, to supply the skin of the chin and lower lip.

The only deeper muscles of facial expression, to which attention need be paid, are the caninus and the buccinator. The caninus lies under cover of the quadratus labii superioris. It arises from the canine fossa of the maxilla, and descends to the angle of the mouth, where some of its fibres are inserted directly into the skin and others join the orbicularis oris. The buccinator lies in the substance of the cheek. It arises from the molar portion of the alveolar process of the maxilla, the external surface of the mandible just below the molar teeth, and the pterygomandibular raphe. The latter is a fibrous band which extends from the pterygoid hamulus to the upper border of the mandible at the junction of the body and the ramus. From this origin the fibres pass forward to be inserted into the mucous membrane of the mouth near the angle of the mouth, and to join the orbicularis oris. Posteriorly, just in front of the masseter, the buccinator is covered

externally by a thick mass of fatty tissue, the suctorial pad, which should be removed in cleaning the muscle. The buccinator is pierced by the parotid duct and by small branches of the buccinator nerve which supply the mucous membrane lining the cheek. Both the caninus and the buccinator are supplied by buccal branches of the facial nerve.

TEMPORAL AND INFRATEMPORAL REGIONS

The temporal fascia is a layer of strong, membranous fascia which covers the external surface of the temporal muscle. External to the temporal fascia are two thin, superficial muscles of the facialis group, the auricularis superior and anterior, whose fibres run in much the same direction as do those of the temporal muscle. They should not be mistaken for the temporal, however, but should be removed in cleaning the temporal fascia. The temporal fascia is attached above to the superior temporal line and below to the upper border of the zygomatic arch and the posterior border of the zygomatic bone. It is thickest inferiorly, where it splits into two layers between which is enclosed a small amount of fatty tissue.

Remove the temporal fascia and clean the external surface of the temporal muscle. The temporal, one of the muscles of mastication, is a strong, fan-shaped muscle which fills the temporal fossa. It arises from the whole of that fossa, with the exception of that part formed by the zygomatic bone, and is inserted into the borders and the entire internal surface of the coronoid process of the mandible. To expose the insertion of the temporal, saw through the zygomatic arch at the anterior and posterior ends of the origin of the masseter, and reflect the arch with the attached masseter downward to the insertion of that muscle. The anterior saw-cut must pass posteriorly from below upward, to avoid injury to the lateral wall of the orbit. As the masseter is reflected a small bit of the muscle substance should be left attached to the nerve which enters its deep surface, so that the nerve may be later recognized and traced to its origin.

When the temporal muscle has been thoroughly cleaned, saw through the coronoid process of the mandible at its junction with the ramus, and reflect the coronoid process with the attached temporal, laterally and upward toward the origin of the muscle. The reflection of the temporal is often complicated by the fact that its deep surface is connected by small muscle fasciculi with the deeper muscles of the region (buccinator and external

pterygoid). Such fasciculi, if they exist, should be cut. The temporal is supplied by two (or three) deep temporal nerves, which will be found running upward on the temporal surface of the great wing of the sphenoid, to enter its deep surface. They should be preserved.

In order fully to open the infratemporal fossa for dissection it is necessary to remove the upper part of the ramus of the mandible. To do this, make two transverse cuts with a saw. The superior cut should pass through the neck of the mandible at its junction with the ramus. The inferior cut

FIG. 11.—Dissection of the infratemporal fossa

must cross the ramus transversely, just high enough to avoid cutting the inferior alveolar nerve, which enters the mandibular foramen on the inner surface of the ramus. To determine the proper level, pass the flat handle of a scalpel forward along the deep surface of the upper part of the ramus. If the handle is then pushed gently downward along the deep surface, its progress will be stopped by the inferior alveolar nerve at the point where that nerve enters the foramen. The lower border of the handle may then be taken as a guide to the proper level for the incision.

The important structures contained within the infratemporal fossa and now to be displayed, are the external and internal pterygoid muscles, the first and second parts of the internal maxillary artery, and the mandibular nerve and its numerous branches. The pterygoid plexus of veins, which drains into the posterior facial vein, surrounds the internal maxillary artery and its branches. The veins should be cut away as the other structures are cleaned.

Clean first the external ptyergoid muscle, taking care to preserve any nerves and arteries which may cross its external surface. The external pterygoid arises by two heads, which are separated from each other by a

slight groove. The lower head, which is the larger, arises from the external surface of the lateral pterygoid plate and from the tuberosity of the maxilla. The upper head arises from the infratemporal surface of the great wing of the sphenoid. The fibres of both heads pass backward and laterally and converge to a tendinous insertion into a depression on the front of the neck of the mandible.

The buccinator nerve, whose distribution as a cutaneous nerve of the cheek has already been seen, will usually be found to emerge from between the two heads of the external pterygoid. The deep temporal nerves usually emerge from under cover of the upper border of the muscle, though the more anterior one may appear between the two heads. Descending from under cover of the inferior border of the external pterygoid, two relatively large nerves will be seen. The more anterior is the lingual nerve; it passes downward and forward, to reach the inner surface of the mandible in the region of the last molar tooth. Just behind the lingual is the inferior alveolar nerve, which enters the mandibular foramen on the inner surface of the ramus; slightly above the mandibular foramen the inferior alveolar gives rise to a small branch, the mylohyoid nerve, which descends in the mylohyoid groove on the inner surface of the mandible, to reach the digastric triangle.

The lingual and inferior alveolar nerves cross the external surface of the internal pterygoid muscle, which should now be cleaned. The internal pterygoid also arises by two heads. The external head, which is very much the smaller, arises from the maxillary tuberosity external to the lowest part of the origin of the lower head of the external pterygoid. The large internal head arises from the pterygoid fossa; this origin is at present hidden by the lower head of the external pterygoid. The main mass of the internal pterygoid lies below the external pterygoid; its fibres run downward, backward, and laterally, to be inserted into the lower half of the internal surface of the ramus of the mandible.

The internal maxillary artery arises behind the neck of the mandible as one of the terminal branches of the external carotid, and runs forward, upward, and medially through the infratemporal fossa to the pterygomaxillary fissure, through which it passes into the pterygopalatine fossa. It is divided for descriptive purposes into three parts, the first and second of which lie in the infratemporal fossa and may now be studied. The first part extends from the external carotid to the lower border of the external

pterygoid). Such fasciculi, if they exist, should be cut. The temporal is supplied by two (or three) deep temporal nerves, which will be found running upward on the temporal surface of the great wing of the sphenoid, to enter its deep surface. They should be preserved.

In order fully to open the infratemporal fossa for dissection it is necessary to remove the upper part of the ramus of the mandible. To do this, make two transverse cuts with a saw. The superior cut should pass through the neck of the mandible at its junction with the ramus. The inferior cut

FIG 11.—Dissection of the infratemporal fossa.

must cross the ramus transversely, just high enough to avoid cutting the inferior alveolar nerve, which enters the mandibular foramen on the inner surface of the ramus. To determine the proper level, pass the flat handle of a scalpel forward along the deep surface of the upper part of the ramus. If the handle is then pushed gently downward along the deep surface, its progress will be stopped by the inferior alveolar nerve at the point where that nerve enters the foramen. The lower border of the handle may then be taken as a guide to the proper level for the incision.

The important structures contained within the infratemporal fossa and now to be displayed, are the external and internal pterygoid muscles, the first and second parts of the internal maxillary artery, and the mandibular nerve and its numerous branches. The pterygoid plexus of veins, which drains into the posterior facial vein, surrounds the internal maxillary artery and its branches. The veins should be cut away as the other structures are cleaned.

Clean first the external ptyergoid muscle, taking care to preserve any nerves and arteries which may cross its external surface. The external pterygoid arises by two heads, which are separated from each other by a

to the capsule, but lies medial to it; it is a thin, fibrous band which runs from the spine of the sphenoid to the lingula of the mandible. Cut through the circumference of the capsule and disarticulate the condyle. Observe the cartilaginous articular disc, which is interposed between the condyle and the temporal bone, and divides the articular cavity into distinct superior and inferior parts.

With the disarticulation of the condyle, the external pterygoid may be reflected laterally and forward. If the second part of the internal maxillary artery lay deep to the external pterygoid it may now be seen, and the middle meningeal artery may be traced to the foramen spinosum. At the same time the mandibular nerve and its branches will be exposed and should be cleaned. (Fig. 12.)

The mandibular nerve emerges from the cranial cavity through the foramen ovale, and divides almost immediately into a small anterior and a large posterior division. The anterior division runs forward under cover of the external pterygoid for a short distance, and then reaches the external surface of that muscle, either by passing between its two heads, or, much less frequently, by winding over its upper border. From this point on it is known as the buccinator nerve, whose further course has already been seen. While still under cover of the external pterygoid, the anterior division gives rise to several muscular branches. These are the deep temporal nerves, which supply the temporal muscle, and the nerves of supply to the masseter and the external pterygoid.

The posterior division of the mandibular nerve descends for a short distance and divides into the lingual, the inferior alveolar, and the auriculotemporal nerves. The lingual and inferior alveolar nerves descend under cover of the external pterygoid to reach the external surface of the internal pterygoid, where they have already been seen. Observe that the lingual is joined, shortly below its origin, by another small nerve, which may be seen running downward and forward medial to the inferior alveolar nerve. This is the chorda tympani. It is a branch of the facial nerve, which leaves the facial while that nerve is still within the facial canal. It passes through the temporal bone, which it leaves at the petro-tympanic fissure, to enter the infratemporal fossa and join the lingual nerve.

The auriculotemporal nerve usually arises by two roots, which embrace the middle meningeal artery and join behind it. The nerve then passes

pterygoid muscle, and lies medial to the neck of the mandible. The second part crosses the lower head of the external pterygoid, passing from the lower border of the muscle to the pterygomaxillary fissure in the region of the interval between the two heads of the muscle. The third part lies in the pterygopalatine fossa and can not now be exposed. The relation of the second part of the artery to the external pterygoid is variable. In about fifty per cent of cases, the artery crosses the external surface of the muscle; in the other fifty per cent it crosses the deep surface, in which eventuality it can not be exposed until the external pterygoid is reflected. The structures supplied with blood by the internal maxillary artery are the same in either case, but the manner of origin of the branches is somewhat different in the two conditions.

In all cases the first part of the internal maxillary gives rise to the inferior alveolar artery, which enters the mandibular foramen in company with the inferior alveolar nerve. In cases where the second part crosses the external pterygoid externally, the further branches are as follows. The first part gives rise to the middle meningeal artery, which ascends deep to the external pterygoid to enter the foramen spinosum. The second part gives rise to a series of muscular branches, which supply the temporal, internal and external pterygoid, and masseter muscles, and to the buccinator artery, which accompanies the buccinator nerve on to the cheek. In cases where the second part of the internal maxillary crosses the deep surface of the external pterygoid, the middle meningeal artery arises from the second part, and will be entirely covered by the external pterygoid, as long as that muscle remains in place. The branches described above as branches of the second part usually here arise from a large common stem which springs from the first part of the internal maxillary and ascends on the external surface of the external pterygoid. (Fig. 11.)

Study the mandibular articulation. This is a diarthrodial joint at which the condyle of the mandible articulates with the mandibular fossa of the temporal bone. It is enveloped in a loose articular capsule, which is strengthened on its lateral aspect by the fibres constituting the temporomandibular ligament. This ligament is attached above to the root of the zygoma, and narrows inferiorly to its attachment on the lateral aspect of the condyle and neck of the mandible. Define the sphenomandibular ligament. This is an accessory ligament of the joint, which is not joined

the inferior border, which rests upon the mylohyoid muscle. The lateral surface is in relation to the sublingual fossa on the internal surface of the mandible; the medial surface rests against the genioglossus, one of the extrinsic muscles of the tongue. The superior surface is in relation to the mucous membrane on the floor of the mouth. The sublingual gland does not possess a single duct, but drains by means of a series of small short ducts, which pass upward from its superior surface to open in to the floor of the mouth. Observe that the duct of the submaxillary gland runs forward and

FIG. 12.—Deep dissection of the submaxillary and infratemporal regions. The external pterygoid muscle and the left side of the mandible have been removed.

upward across the muscles of the tongue, passing deep to the lingual nerve and the sublingual gland, to open into the floor of the mouth near the anterior end of the sublingual gland.

The lingual nerve has already been traced from its origin to the point where it lies between the internal surface of the mandible and the mucous lining of the mouth in the region of the last molar tooth. It should now be followed downward and forward across the muscles of the tongue to the deep surface of the sublingual gland, where it breaks up into its terminal branches. These branches are distributed to the mucous membrane of the tongue. The lingual is the sensory nerve of the anterior two-thirds of the tongue. It mediates impulses both of general sensibility and of the special sense of taste for this area. The former are carried through the lingual branch of the mandibular, the latter through the chorda tympani of the facial.

posteriorly, to wind laterally behind the mandibular joint, and turn upward over the root of the zygoma, from which point its further course has been traced.

Attempt to demonstrate the nerve of supply to the internal pterygoid muscle. This small nerve usually arises directly from the trunk of the mandibular just below the foramen ovale, and enters the upper part of the internal pterygoid.

With a mallet and chisel, aided if necessary by bone forceps, carefully chip away the outer table of the mandible, to open the mandibular canal and expose the further course of the inferior alveolar nerve. This nerve runs forward through the mandible, and gives off dental branches to the roots of all the lower teeth, and gingival branches to the mucous membrane of the gum, all of which pass through minute canals in the bone. At the mental foramen it gives rise to the mental nerve, which passes through the foramen on to the face. The inferior alveolar artery accompanies the nerve and gives rise to small branches which correspond to those of the nerve.

SUBMAXILLARY REGION

Review the boundaries and contents of the digastric triangle. Then detach the anterior belly of the digastric from the mandible, sever the intermediate tendon, and remove the anterior belly. Review the attachments of the mylohyoid muscle. Then detach it from its origin on the mylohyoid line and turn it downward and laterally, or remove it altogether. Saw through the mandible vertically just in front of the mental foramen and turn the posterior segment of the bone upward. By this means the sublingual gland, the deep portion and duct of the submaxillary gland, the terminal parts of the lingual and hypoglossal nerves, the submaxillary ganglion, the extrinsic muscles of the tongue, and a part of the deep surface of the mucous membrane lining the mouth will be exposed. The superficial portion of the submaxillary gland may be cut away, if desired, leaving only the deep portion and the bit of the superficial portion from which the duct issues.

Clean the sublingual gland. This is a lobulated structure, which is flattened from side to side, so as to present a lateral surface, a medial surface, and a narrow superior surface. The lateral and medial surfaces meet at

The styloglossus is a slender muscle, which arises from the tip of the styloid process and runs downward and forward to reach the side of the tongue, where its fibres interlace with those of the hyoglossus.

The stylohyoid muscle has already been cleaned. Observe now that it arises from the base of the styloid process and winds downward, forward, and laterally, to cross the external carotid artery externally. Arising from the styloid process between the origins of the stylohyoid and the styloglossus is a third slender muscle, whose upper portion should now be cleaned. This is the stylopharyngeus; it passes downward, forward, and medially, to enter the wall of the pharynx. Running downward and forward across the external surface of the stylopharyngeus, the terminal part of the glossopharyngeal nerve may now be seen. This is the ninth cranial nerve, which provides the sensory innervation of the posterior third of the tongue. Near the posterior border of the hyoglossus it breaks up into terminal branches, which supply the mucous membrane of the posterior third of the tongue, mediating impulses both of general sensibility and of taste for this area.

The origin of the lingual artery as a branch of the external carotid has already been seen in the dissection of the carotid triangle. The full course of this vessel may now be studied. The first part of the lingual artery extends from the external carotid to the posterior border of the hyoglossus; it has no branches of importance. The second part extends transversely forward, deep to the hyoglossus, a short distance above the hyoid bone. Divide the hyoglossus transversely just above the hyoid bone, and turn it upward, to expose this portion of the vessel. Near the anterior border of the hyoglossus the lingual artery terminates by dividing into the sublingual and deep lingual arteries. From the second part of the lingual arise two or three dorsal lingual branches, which ascend into the substance of the posterior part of the tongue. The sublingual artery runs forward and upward across the genioglossus, to supply the sublingual gland and neighboring structures. The deep lingual runs upward on the genioglossus and bends forward into the free portion of the tongue, where it reaches as far as the tip.

Identify the submaxillary ganglion. This is a small nervous mass, which lies below the lingual nerve in the region of the submaxillary gland. It is connected to the lingual nerve by two short communicating branches. It contains the cell-bodies of post-ganglionic neurons of the parasympathetic system. Pre-ganglionic nerve fibres reach it from the lingual nerve; these are derived from the facial nerve through the chorda tympani. Of the post-ganglionic fibres which leave the ganglion, some pass directly into the submaxillary gland for its supply, while others pass back into the lingual nerve to be distributed to the sublingual gland.

The hypoglossal nerve has already been followed to the point at which it passes under cover of the mylohyoid muscle. Its further course may now be seen. It passes forward across the hyoglossus, where it gives branches to that muscle and to the styloglossus, and on to the genioglossus. Here it gives a branch to the geniohyoid, and breaks up into terminal branches, which enter the substance of the tongue, to supply the genioglossus and the intrinsic musculature of the tongue. It is usually connected, near the anterior border of the hyoglossus, by an anastomosing loop with the lingual nerve. The hypoglossal is the motor nerve of the tongue, supplying all of the extrinsic and intrinsic muscles of that organ.

The extrinsic muscles of the tongue should now be cleaned. They are the styloglossus, hyoglossus, and genioglossus. All have bony origins external to the tongue and are inserted into the fleshy mass of the tongue, where their fibres mingle with one another and with the fibres of the intrinsic muscles. The geniohyoid is not actually a muscle of the tongue, but may best be considered with this group.

The hyoglossus is a thin, quadrilateral sheet of muscle which arises from the lateral part of the body and the upper border of the greater cornu of the hyoid bone. Its fibres pass vertically upward into the tongue and interlace with the intrinsic muscle fibres and with the styloglossus. (Fig. 12.)

The geniohyoid is a flat, triangular muscle, which arises from the mental spine (genioid tubercle) on the internal aspect of the mandibular symphysis and is inserted on the upper border of the body of the hyoid bone. Immediately above it is the genioglossus, which also takes origin at the mental spine. From this origin its fibres radiate upward and posteriorly into the tongue, the lower ones passing deep to the hyoglossus; a few of its lowest fibres are inserted on the hyoid bone.

forceps, divide the styloid process near its base, and reflect it, together with the attached styloglossus and stylopharyngeus, laterally and forward. Then clean and study the glossopharyngeal, vagus, accessory, and hypoglossal nerves as they emerge at the base of the skull. (Fig. 13.)

Observe that the glossopharyngeal, vagus, and accessory emerge from the medial end of the jugular foramen, lying medial and slightly anterior to the beginning of the internal jugular vein. The glossopharyngeal nerve is the most medial of the three. It descends vertically for a short distance and then turns forward, to cross the lateral aspect of the internal carotid

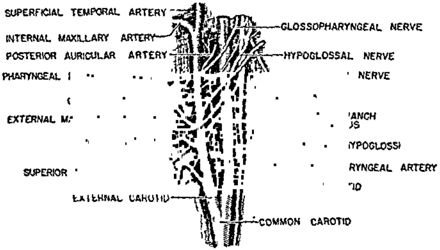

FIG. 13.—Semi-diagrammatic lateral view of the carotid arteries and the nerves associated with them on the left side of the neck.

artery, and wind laterally around the stylopharyngeus muscle. In the upper part of its course the glossopharyngeal gives branches to the wall of the pharynx. As it winds around the stylopharyngeus it gives a twig of supply to that muscle. Its further distribution, to the posterior part of the tongue, has already been seen.

The vagus and accessory nerves are bound in a common sheath in the jugular foramen. The vagus descends almost vertically, lying in the carotid sheath, where the greater part of its cervical course has already been exposed. Just below the jugular foramen it receives a communicating branch from the accessory. Slightly lower it exhibits an ovoid swelling, the ganglion nodosum. Just below the ganglion, the vagus gives off its pharyngeal branch, which runs forward, lateral to the internal carotid artery, to reach the wall of the pharynx, where it joins with the pharyngeal branches of the glossopharyngeal nerve, to form the pharyngeal plexus. Somewhat below the origin of the pharyngeal branch, the vagus gives rise to a larger branch,

DEEP DISSECTION OF THE SIDE OF THE NECK

Study the cervical portion of the sympathetic trunk. The trunk lies behind the carotid sheath in the fascia covering the anterior surfaces of the prevertebral muscles. It begins in front of the second cervical vertebra, and descends to the neck of the first rib, in front of which it passes, to become continuous with the thoracic portion of the trunk. The cervical portion exhibits three ganglionic enlargements in its course. The largest of these is the superior ganglion, which lies in front of the second and third vertebrae and represents the highest part of the trunk. The middle ganglion is small, sometimes lacking, and lies in front of the sixth vertebra. The inferior ganglion lies just below the seventh vertebra; it is frequently fused with the first thoracic ganglion to form a large ganglionic mass in front of the neck of the first rib, which is known as the stellate ganglion. From each of the cervical sympathetic ganglia there arises a cardiac branch, which descends into the thorax to join the cardiac plexus. In addition to these, communicating branches pass laterally to join the cervical nerves. The superior ganglion usually communicates with the first four cervical nerves, the middle ganglion with the fifth and sixth, and the inferior ganglion with the seventh and eighth. Above the superior ganglion, the trunk is continued as the internal carotid nerve, which accompanies the internal carotid artery into the carotid canal.

Refer to the external base of a macerated skull, and review the positions of the jugular foramen, the hypoglossal foramen, and the external orifice of the carotid canal. In the jugular foramen the internal jugular vein begins, and through it the glossopharyngeal, vagus, and accessory nerves leave the cranial cavity. The hypoglossal nerve leaves the cranial cavity at the hypoglossal foramen. As these structures descend in the neck they all pass deep to the posterior belly of the digastric muscle. In order to expose their upper portions, the digastric should be cut away from its attachment to the internal aspect of the mastoid process.

Cut the stylohyoid muscle away from its origin on the styloid process. Observe that the stylopharyngeus and styloglossus muscles, as they run downward and forward to reach the tongue and the pharynx respectively, cross between the internal and the external carotid arteries, lying lateral (superficial) to the former and medial (deep) to the latter. With bone

forceps, divide the styloid process near its base, and reflect it, together with the attached styloglossus and stylopharyngeus, laterally and forward. Then clean and study the glossopharyngeal, vagus, accessory, and hypoglossal nerves as they emerge at the base of the skull. (Fig. 13.)

Observe that the glossopharyngeal, vagus, and accessory emerge from the medial end of the jugular foramen, lying medial and slightly anterior to the beginning of the internal jugular vein. The glossopharyngeal nerve is the most medial of the three. It descends vertically for a short distance and then turns forward, to cross the lateral aspect of the internal carotid

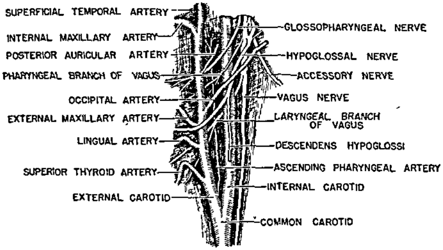

FIG. 13.—Semi-diagrammatic lateral view of the carotid arteries and the nerves associated with them on the left side of the neck.

artery, and wind laterally around the stylopharyngeus muscle. In the upper part of its course the glossopharyngeal gives branches to the wall of the pharynx. As it winds around the stylopharyngeus it gives a twig of supply to that muscle. Its further distribution, to the posterior part of the tongue, has already been seen.

The vagus and accessory nerves are bound in a common sheath in the jugular foramen. The vagus descends almost vertically, lying in the carotid sheath, where the greater part of its cervical course has already been exposed. Just below the jugular foramen it receives a communicating branch from the accessory. Slightly lower it exhibits an ovoid swelling, the ganglion nodosum. Just below the ganglion, the vagus gives off its pharyngeal branch, which runs forward, lateral to the internal carotid artery, to reach the wall of the pharynx, where it joins with the pharyngeal branches of the glossopharyngeal nerve, to form the pharyngeal plexus. Somewhat below the origin of the pharyngeal branch, the vagus gives rise to a larger branch,

the superior laryngeal nerve. This nerve runs downward and forward, passing deep to the internal carotid artery, and divides into the internal and external laryngeal nerves, which have already been exposed in the dissection of the carotid triangle.

The accessory nerve, below its communication with the vagus, bends laterally, to cross either in front or behind the internal jugular vein, and turns posteriorly and downward to pass deep to the posterior belly of the digastric and the occipital artery and reach the deep surface of the sternomastoid, from which point its further course has been studied.

The hypoglossal nerve, as it emerges from the hypoglossal foramen, lies medial to the vagus and accessory nerves. As it descends it takes a spiral course around the vagus, passing first behind and then lateral to that nerve. Descending across the deep surface of the posterior belly of the digastric, it is crossed externally by the occipital artery, and then bends forward across the external aspect of the external carotid artery to enter the carotid triangle, from which point its further course has already been traced.

The internal carotid artery begins at about the level of the upper border of the thyroid cartilage, as one of the terminal branches of the common carotid, and ascends in front of the upper three cervical vertebrae to the base of the skull, where it enters the carotid canal. It has no branches in the neck. At its beginning it is relatively superficial, lying in the carotid triangle, but passing deep to the digastric and stylohyoid muscles, it soon becomes much more deeply placed. It is crossed externally by the styloglossus and stylopharyngeus, the tip of the styloid process, and by the glossopharyngeal nerve and the pharyngeal branch of the vagus, all of which intervene between the internal and external carotids. The internal carotid is in relation medially with the pharyngeal wall. Posteriorly it rests against the prevertebral muscles and the sympathetic trunk. Laterally it is in relation to the internal jugular vein and the vagus nerve.

Attempt to display the three small arteries which supply the upper part of the wall of the pharynx. These are the ascending pharyngeal, the ascending palatine, and the tonsillar arteries; all three of these vessels are not usually present in a single individual, however, the one which is lacking being replaced by branches from the other two. The ascending pharyngeal is usually the first branch of the external carotid. Arising from the medial aspect of that vessel, it ascends deeply on the wall of the pharynx, where

it lies medial to the internal carotid artery. The ascending palatine and the tonsillar arteries are two small branches of the external maxillary artery, which arise from that vessel as it lies deep to the digastric muscle. They ascend on the upper lateral part of the pharyngeal wall, the ascending palatine lying slightly posterior to the tonsillar. The former passes deep to the styloglossus, the latter crossing that muscle superficially. (Fig. 12.)

THE CRANIAL CAVITY

As a preparation for the opening of the cranial cavity, the bony vault of the skull should be stripped bare. To do this, make a median sagittal incision through the scalp, including any skin which may remain on the back of the head, from the glabella to the external occipital protuberance. The various layers of the scalp may then be all turned downward and laterally together on each side, leaving the external surface of the bones of the cranial vault clean. Any remnants of the temporal muscle should also be removed from the upper part of the temporal fossa. Then tie a string around the cranium, and mark on the bone with a pencil carried along the string, the line on which the cranial cavity is to be opened. Anteriorly this line should be about three quarters of an inch above the upper margin of the orbits, and posteriorly about the same distance above the external occipital protuberance.

With a saw, cut through the outer table of the bones along this line. When the diploe is reached the saw should be discarded and the inner table broken through with a chisel. The calvaria may then be pulled off and the external surface of the dura mater of the brain will be exposed.

The cranial dura consists of two layers, the outer of which is actually the periosteum of the inner surface of the cranial bones. The inner, or supporting layer of the cranial dura, is analogous to the spinal dura, with which it is continuous at the foramen magnum. The two layers of the cranial dura are in most regions firmly attached to one another, but in certain places they separate to enclose blood spaces, the sinuses of the dura mater. The dural sinuses are in fact veins, but they differ from typical veins in that the actual wall of the vessel consists only of an endothelial layer, the chief support of the wall being provided by the dura mater in which the vessel is enclosed. The outer layer of the cranial dura is everywhere in close relation to the inner surface of the cranial bones. The inner

layer, however, shows reduplications, or double folds, which project into the cranial cavity and partially subdivide it. These reduplications, which will be seen as the dissection proceeds, are the falx cerebri, the tentorium cerebelli, and the falx cerebelli.

Make a sagittal incision through the dura about half an inch lateral to the midline on each side, from the frontal to the occipital region; passing laterally from either end of these incisions, make transverse incisions, and turn the flaps of dura thus marked out laterally, to expose the subdural space and the arachnoid. The cranial arachnoid is a delicate membrane, through which the upper surface of the cerebral hemispheres will be readily seen. No special study of the cranial arachnoid need be made, but it may be removed with the brain.

Observe the numerous cerebral veins, which leave the upper surface of the cerebral hemispheres and pierce the arachnoid to enter the dura close to the median line. These veins carry blood to the superior sagittal sinus, which should now be opened. To do this it is necessary only to make a median sagittal incision in the dura. The superior sagittal sinus is enclosed within the dura mater. It begins anteriorly at the crista galli of the ethmoid bone and extends posteriorly along the cranial vault in the median plane to the internal occiptal protuberance, where it ends by joining the right (less frequently the left) transverse sinus. In its course it receives the superior cerebral veins.

Spread the cerebral hemispheres apart and observe the falx cerebri. This is a double fold of the inner layer of the dura mater, which stretches downward in the median plane between the two hemispheres. Superiorly its two layers separate to enclose the superior sagittal sinus and to become continuous with the inner layer of the dura of the cranial vault on either side. Anteriorly it is attached to the crista galli. Its inferior border is free, except in the posterior part of the cranial cavity. Enclosed within this lower free margin is the inferior sagittal sinus. Posteriorly the falx cerebri is joined at its inferior margin to the tentorium cerebelli.

Cut the falx cerebri away from the crista galli and draw its free anterior portion upward and posteriorly out of the cleft between the two cerebral hemispheres. Tilt the head well backward and draw the frontal lobes of the cerebrum upward and backward from the floor of the anterior cranial fossa. As this is done, the minute filaments of the olfactory nerves may be

seen piercing the cribriform plate of the ethmoid to reach the olfactory bulb. The optic nerves also will come into view passing from the base of the diencephalon to the optic foramina. They should be cut, just posterior to the optic foramina. Just below the optic foramen the internal carotid artery will be seen, running posteriorly to reach the base of the brain. The artery also should be cut on each side. In the midline, between the two internal carotids, the infundibulum will appear. This narrow stalk, which connects the base of the brain with the hypophysis, must also be severed. If the temporal lobes of the cerebral hemispheres are now dislodged from the middle cranial fossa and both hemispheres tilted still farther upward and backward, the anterior part of the tentorium cerebelli, which roofs the posterior cranial fossa, will be seen, and passing upward from the posterior fossa at the free margin of the tentorium, a portion of the brain stem, the mesencephalon, will appear. This should be cut through in a transverse plane, just above the tentorium cerebelli. The cerebral hemispheres, together with the diencephalon and the upper segment of the mesencephalon, will then be free and can be removed from the cranial cavity.

The tentorium cerebelli should now be examined. It is a transverse reduplication of the inner layer of the cranial dura, which is interposed between the posterior parts of the cerebral hemispheres and the cerebellum. Its outer border is attached on each side to the posterior clinoid process, the superior border of the petrous portion of the temporal bone, the postero-inferior angle of the parietal bone, and the transverse ridges of the occipital bone. Its inner or anterior border is free and forms the margin of an opening, the tentorial notch, through which the posterior cranial fossa communicates with the general cranial cavity. In the median line, the upper surface of the tentorium is joined to the inferior border of the posterior part of the falx cerebri.

Open the venous sinuses which are enclosed by the layers of the tentorium. In the median plane, along the line of junction of the tentorium and the falx, is the *straight sinus*. This sinus begins as a continuation of the inferior sagittal sinus, at the tentorial notch, where it also receives the great cerebral vein, and passes straight backward to the internal occipital protuberance, where it ends, usually by joining the left transverse sinus. The transverse sinus of each side begins at the internal occipital protuberance and passes laterally, enclosed within the attached margin of the tentorium,

layer, however, shows reduplications, or double folds, which project into the cranial cavity and partially subdivide it. These reduplications, which will be seen as the dissection proceeds, are the falx cerebri, the tentorium cerebelli, and the falx cerebelli.

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Observe the numerous cerebral veins, which leave the upper surface of the cerebral hemispheres and pierce the arachnoid to enter the dura close to the median line. These veins carry blood to the superior sagittal sinus, which should now be opened. To do this it is necessary only to make a median sagittal incision in the dura. The superior sagittal sinus is enclosed within the dura mater. It begins anteriorly at the crista galli of the ethmoid bone and extends posteriorly along the cranial vault in the median plane to the internal occipital protuberance, where it ends by joining the right (less frequently the left) transverse sinus. In its course it receives the superior cerebral veins.

Spread the cerebral hemispheres apart and observe the falx cerebri. This is a double fold of the inner layer of the dura mater, which stretches downward in the median plane between the two hemispheres. Superiorly its two layers separate to enclose the superior sagittal sinus and to become continuous with the inner layer of the dura of the cranial vault on either side. Anteriorly it is attached to the crista galli. Its inferior border is free, except in the posterior part of the cranial cavity. *Enclosed within this lower free* margin is the inferior sagittal sinus. Posteriorly the falx cerebri is joined at its inferior margin to the tentorium cerebelli.

Cut the falx cerebri away from the crista galli and draw its free anterior portion upward and posteriorly out of the cleft between the two cerebral hemispheres. Tilt the head well backward and draw the frontal lobes of the cerebrum upward and backward from the floor of the anterior cranial fossa. As this is done, the minute filaments of the olfactory nerves may be

the pons the brain stem narrows to the medulla oblongata. Arising from the sides of the medulla are the roots of the vagus, glossopharyngeal, and accessory nerves, and from its inferior surface the various filaments which join to form the hypoglossal nerve. When the roots of all of these nerves have been severed close to their points of emergence from the brain, the medulla should be divided transversely just above the foramen magnum and the brain completely removed from the cranial cavity.

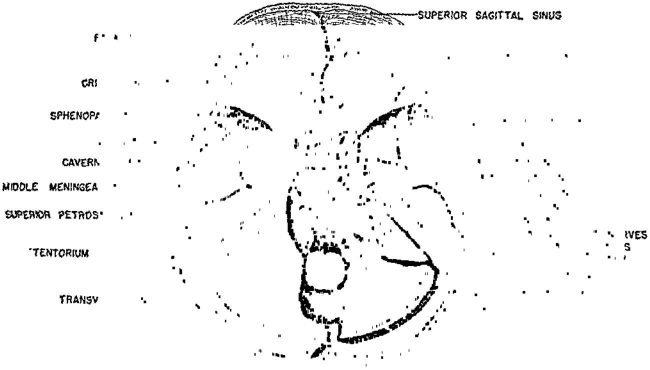

Fig. 14.—The interior of the cranial cavity after removal of the brain. The tentorium cerebelli has been removed on the right side, and the transverse, superior petrosal, and cavernous sinuses opened.

Compare the floor of the cranial cavity as it now appears with the internal base of a macerated skull. The differences which will at once appear depend on the fact that the inner layer of the cranial dura does not in all regions closely follow the contour of the bones, but is separated to some extent from the outer layer by structures which are interposed between the two layers. This is particularly true in the middle cranial fossa, where it should be noted that nothing can be seen of the superior orbital fissure, the foramen rotundum, the foramen ovale, the carotid canal, or the foramen spinosum, as long as the inner layer of the dura is intact, since all of these openings are bridged over internally by the inner layer of the dura. Certain of the cranial nerves pierce the inner layer of the dura at a considerable distance from the foramina by which they leave the skull, and pass forward between the two layers to reach these foramina.

along the occipital bone; at the lateral end of the superior border of the petrous part of the temporal bone it turns downward in the dura lining the wall of the posterior cranial fossa, where its further course may be seen after the tentorium has been removed. The right transverse sinus most commonly begins as a continuation of the superior sagittal sinus and the left as a continuation of the straight sinus. This relationship may, however, be reversed, or all four sinuses may communicate at the internal occipital protuberance.

The superior petrosal sinus is enclosed in the outer margin of the tentorium, along the line of attachment of that margin to the superior border of the petrous part of the temporal bone. It begins just lateral to the posterior clinoid process, where it receives blood from the cavernous sinus, and ends by joining the transverse sinus at the point where the latter turns inferiorly.

Make a sagittal incision in the tentorium slightly to the left of the median line. Then raise the right half of the cut tentorium and observe the falx cerebelli. This is a short vertical reduplication of the inner layer of the dura, which passes downward in the median plane from the under surface of the tentorium into the cleft between the cerebellar hemispheres. *Reflect the severed halves of the tentorium upward and laterally to expose the contents of the posterior cranial fossa.* These are the cerebellum, the posterior segment of the mesencephalon, the pons, and the medulla oblongata. *These portions of the brain should now be lifted from the floor of the posterior fossa. As this is done the remaining cranial nerves should be identified, and divided close to their points of attachment to the brain.*

The oculomotor nerves are relatively large. They arise from the lower surface of the midbrain near the median line. The trochlear nerves are much smaller; they wind downward around the lateral border of the posterior part of the midbrain. Arising from the side of the pons will be seen the various filaments which make up the roots of the trigeminal nerve. At the posterior border of the pons, near the median line, is the origin of the abducens nerve. Slightly more laterally, the facial and acoustic nerves will be seen to leave the posterior border of the pons. In the median line, the basilar artery will be found running forward in close relation to the inferior surface of the pons; *it also should be divided.* Below and behind

The oculomotor and trochlear nerves pass forward in the upper part of the lateral wall of the cavernous sinus. The oculomotor is the highest of all the nerves, the trochlear lying between the oculomotor and the ophthalmic. Both of these nerves enter the orbit at the superior orbital fissure. The abducens nerve projects farther medially into the cavernous sinus; it runs forward, medial to the ophthalmic nerve and lateral to the internal carotid artery, to enter the orbit at the superior orbital fissure.

The internal carotid artery enters the cranial cavity at the internal opening of the carotid canal, which lies just above the foramen lacerum. Running forward between the two layers of the dura, the artery enters the wall of the cavernous sinus. Below the anterior clinoid process it turns upward, medially, and then backward, to pierce the inner layer of the dura just below and behind the optic foramen. As it emerges from the dura it gives rise to the ophthalmic artery, which passes forward into the orbit through the optic foramen, where it lies immediately below the optic nerve.

Observe that the facial and acoustic nerves leave the posterior cranial fossa by entering together the internal auditory meatus in the petrous part of the temporal bone. The glossopharyngeal, vagus, and accessory nerves enter the medial end of the jugular foramen. Medial to the jugular foramen, close to the antero-lateral margin of the foramen magnum, is the hypoglossal foramen, by which the hypoglossal nerve leaves the cranial cavity. Observe that the vertebral artery enters the cranium on either side at the lateral margin of the foramen magnum. Passing forward and medially over the floor of the posterior fossa, the two vertebral arteries join to form the basilar artery.

The transverse sinus has already been opened as far as the point in the peripheral attached margin of the tentorium cerebelli where it is joined by the superior petrosal sinus. Its terminal portion should now be opened. Observe that it pursues a curved course downward and medially, within the dura mater lining the posterior fossa, to the lateral part of the jugular foramen. The transverse sinus terminates in the jugular foramen, below which it is continuous with the internal jugular vein. The inferior petrosal sinus lies in the groove between the basal portion of the occipital bone and the petrous portion of the temporal. It runs from the lower posterior part of the cavernous sinus to the jugular foramen, where it joins the internal jugular vein.

Observe the points at which the oculomotor, trochlear, trigeminal, and abducens nerves pierce the inner layer of dura. The oculomotor is most anterior, entering the dura at the side of the posterior clinoid process. The trochlear nerve enters the dura at the most anterior point of attachment of the tentorium cerebelli. The point of entrance of the trigeminal nerve is slightly posterior and inferior to that of the trochlear; it is covered superiorly by the narrow anterior part of the tentorium. The abducens nerve enters the dura well back on the floor of the posterior fossa. To follow the further course of these nerves the inner layer of the dura must be carefully stripped away from the floor of the middle cranial fossa at the side of the hypophyseal fossa. As this is done, the cavernous sinus will be opened.

The cavernous sinus is a venous sinus which lies between the two layers of the dura at the side of the hypophyseal fossa. It receives blood from the superior and inferior ophthalmic veins, which enter it from the orbit by passing through the superior orbital fissure, and from the sphenoparietal sinus, which lies within the dura along the free margin of the lesser wing of the sphenoid bone. It drains posteriorly by means of the superior and inferior petrosal sinuses. The cavernous sinuses of the two sides are united by the anterior and posterior intercavernous sinuses, which lie in the dura covering the hypophysis in front of and behind the infundibulum. In close relation to the lateral wall of the cavernous sinus are the trochlear and oculomotor nerves, the semilunar ganglion, and the ophthalmic and maxillary divisions of the trigeminal nerve. Projecting farther medially into the sinus are the abducens nerve and the internal carotid artery.

Clean the trigeminal nerve. Shortly after it enters the dura, the root fibres of this nerve expand to form the semilunar ganglion. This large ganglion is covered by the inner layer of dura forming the lower lateral part of the wall of the cavernous sinus. From the ganglion the ophthalmic division of the trigeminal passes forward in the lateral wall of the sinus to reach the superior orbital fissure. As it reaches the superior orbital fissure the ophthalmic nerve divides into the lacrimal, frontal, and nasociliary nerves, but these can probably not be identified until the orbit is opened. Below the ophthalmic, in the lower part of the lateral wall of the cavernous sinus, the maxillary division of the trigeminal runs forward to the foramen rotundum. The mandibular division passes directly downward from the posterior part of the ganglion to the foramen ovale.

The oculomotor and trochlear nerves pass forward in the upper part of the lateral wall of the cavernous sinus. The oculomotor is the highest of all the nerves, the trochlear lying between the oculomotor and the ophthalmic. Both of these nerves enter the orbit at the superior orbital fissure. The abducens nerve projects farther medially into the cavernous sinus; it runs forward, medial to the ophthalmic nerve and lateral to the internal carotid artery, to enter the orbit at the superior orbital fissure.

The internal carotid artery enters the cranial cavity at the internal opening of the carotid canal, which lies just above the foramen lacerum. Running forward between the two layers of the dura, the artery enters the wall of the cavernous sinus. Below the anterior clinoid process it turns upward, medially, and then backward, to pierce the inner layer of the dura just below and behind the optic foramen. As it emerges from the dura it gives rise to the ophthalmic artery, which passes forward into the orbit through the optic foramen, where it lies immediately below the optic nerve.

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Observe the distribution of the middle meningeal artery. This vessel, a branch of the internal maxillary artery, enters the cranial cavity at the foramen spinosum, and divides almost at once into anterior and posterior branches, which are distributed to the dura mater of the floors of the anterior and middle cranial fossae and of the cranial vault. These vessels are embedded in the outer layer of the dura, but can usually be clearly seen through the dura without dissection. The dura of the posterior cranial fossa is supplied by one or two small meningeal branches of the occipital artery, which reach the dura by passing through the jugular foramen.

THE ORBIT

From the front of the orbit draw the eyeball forward with forceps; make a small opening in the cornea and stuff the eyeball with cotton or small bits of cheese-cloth, to restore its normal rounded contour. The orbit is then to be opened by the removal of a triangular piece from its roof. Make two vertical cuts with a saw through the squamous part of the frontal bone above the orbit. These cuts should reach the superior orbital margin about a quarter of an inch lateral and medial to the superior medial and superior lateral angles respectively. Both cuts should then be prolonged backward through the bone forming the floor of the anterior cranial fossa, to the base of the anterior clinoid process. The more medial of these cuts will be parallel and about half an inch lateral to the mid-sagittal plane; the more lateral cut will pass obliquely backward and medially. If the two cuts do not meet at the anterior clinoid process they may be joined by a short transverse incision made with a chisel. The triangular piece of bone thus marked out may then be tilted upward and forward; the soft parts remaining around the superior orbital margin will act as a hinge, so that the bony roof of the orbit need not be completely removed, but simply tilted well forward. The lesser wing of the sphenoid may be chipped carefully away with bone forceps, so as completely to open the superior orbital fissure from above; it is advisable, however, to leave the bony rim of the optic foramen intact.

If the orbit has been carefully opened, the periosteum of its roof, which is very loosely attached to the bone, will remain intact. This periosteum should now be slit longitudinally and reflected to either side, to expose the cavity of the orbit from above. The structures contained in the orbit are

embedded in loose fatty tissue, which must be removed bit by bit as the dissection proceeds.

The structures which lie highest in the orbit, and which should first be cleaned, are three nerves, the trochlear, the frontal, and the lacrimal, all of which enter through the upper part of the superior orbital fissure. The trochlear nerve is the most medial; it passes forward and medially to end in the superior oblique muscle, which may be seen occupying the angle of junction of the roof and medial wall of the orbit.

The frontal nerve is the largest of the three terminal branches of the ophthalmic nerve. It passes forward under the middle of the roof of the orbit, where it lies immediately above the levator palpebrae superioris

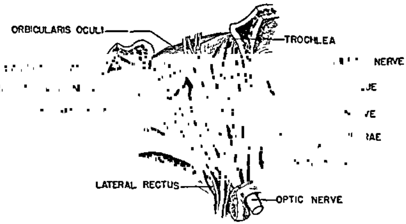

FIG. 15.—The left orbit, seen from above after removal of its roof.

muscle. About midway in its course through the orbit, the frontal nerve divides into a small supratrochlear and a larger supraorbital branch. The supratrochlear passes forward and medially, to emerge on to the face at the superior margin of the orbit just above the trochlea for the superior oblique muscle. The supraorbital continues forward, to turn upward on to the forehead at the supraorbital notch or foramen; it frequently divides into two or more branches before reaching the supraorbital notch.

The lacrimal nerve is the smallest of the three branches of the ophthalmic. It passes forward along the line of junction of the roof and the lateral wall of the orbit, to end in minute twigs to the skin of the lateral part of the upper eyelid. It also gives a few small twigs to the lacrimal gland.

The lacrimal gland is a small, oval, lobulated structure, which lies in the upper anterior lateral part of the orbit. Its secretion is poured into the upper part of the conjunctival sac through a number of minute ducts.

Clean the levator palpebrae superioris. This narrow flat muscle arises at the upper margin of the optic foramen and runs forward, just below the roof of the orbit, to be inserted into the superior tarsus. The superior tarsus is a thin but strong plate of fibrous tissue which lies in the upper eyelid behind the orbicularis oculi and in front of the palpebral conjunctiva.

Immediately below the levator palpebrae superioris is the superior rectus muscle. This is also a flat, band-like muscle, somewhat wider than the levator, which arises from the upper margin of the optic foramen and is inserted into the sclera of the eyeball. The ocular muscles can not all be exposed at present, but it is well to have a general idea of their arrangement and attachments before proceeding further with the dissection of the orbit. The superior, medial, inferior, and lateral rectus muscles are all flat band-like muscles which arise at the apex of the orbit from the bony rim of the optic foramen, their origins thus encircling the optic nerve as it enters the orbit. Spreading forward through the orbit they are all inserted into the sclera at points anterior to a plane which would divide the eyeball into anterior and posterior halves. The superior oblique muscle, which may now be cleaned, also arises from the margin of the optic foramen, between the origins of the superior and medial recti. Its fibres pass forward to the trochlea at the upper medial angle of the orbital rim, and here the muscle turns downward, laterally, and posteriorly, passing under the superior rectus, to reach the sclera, where it is inserted on the lateral side, posterior to the plane dividing the eyeball into anterior and posterior halves. The inferior oblique muscle lies deeply in the anterior part of the orbit, where it will be seen in the final stages of the dissection.

Divide the frontal nerve a short distance in front of the optic foramen and turn it forward. Divide the levator palpebrae superioris and the superior rectus at about the middle of the orbit and turn the anterior cut segments of the two muscles forward. Then turn the posterior cut segments backward; as this is done the superior division of the oculomotor nerve will be found entering the deep surface of the superior rectus, which it supplies; a small branch of this nerve either pierces the superior rectus or winds around its medial border, to supply the levator palpebrae superioris.

Reference to a macerated skull will show that the lateral rectus muscle, in passing from its origin to its insertion must cross in front of the superior orbital fissure. The nerves already displayed near the roof of the orbit

(i.e., the lacrimal, frontal, and trochlear) enter the upper part of the superior orbital fissure and pass above the lateral rectus. The nasociliary, oculomotor, and abducens nerves pass through the superior orbital fissure at a lower level and pierce the lateral rectus near its origin, to enter the orbit more deeply. With the reflection of the superior rectus and the levator palpebrae superioris these nerves may now be displayed.

The nasociliary is the third branch of the ophthalmic nerve. Passing forward and medially, it crosses above the optic nerve, and ends near the upper anterior part of the medial wall of the orbit by dividing into the infratrochlear and the anterior ethmoidal nerves. Before its termination

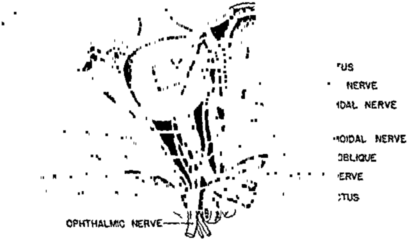

FIG. 16.—Deep dissection of the left orbit. The ophthalmic artery is not shown.

it gives rise to the long root of the ciliary ganglion, the long ciliary nerves, and the posterior ethmoidal nerve. The long root of the ciliary ganglion is a small nerve which arises from the nasociliary far back in the orbit and passes forward along the lateral side of the optic nerve to reach the ciliary ganglion. The long ciliary nerves are three or four fine filaments which arise from the nasociliary as that nerve crosses above the optic nerve, and pass forward to pierce the posterior part of the sclera. The posterior ethmoidal nerve passes medially above the medial rectus, and enters the posterior ethmoidal foramen, to reach the mucosa of the ethmoidal air cells. The anterior ethmoidal is the largest branch of the nasociliary. It crosses above the medial rectus and enters the anterior ethmoidal foramen, eventually to reach the nasal cavity, where its further distribution will be studied later. The infratrochlear nerve passes forward, above the anterior part of the medial rectus and below the trochlea of the superior oblique, to reach the skin of the face.

The oculomotor nerve, as it passes through the lateral rectus muscle, divides into a superior and an inferior division. The superior division turns upward, lateral to the optic nerve, to supply the superior rectus and the levator palpebrae superioris, as already observed. The inferior division runs forward for a short distance and then divides into three branches. Of these, one crosses below the optic nerve to supply the medial rectus; another sinks into the inferior rectus for the supply of that muscle; the third runs forward along the floor of the orbit, to reach the inferior oblique muscle. From the branch to the inferior oblique, near its origin, arises the short root of the ciliary ganglion.

The ciliary ganglion is very small. It lies in the posterior part of the orbit, at the lateral side of the optic nerve. It receives roots from the nasociliary and the oculomotor nerves. The branches which arise from it are the short ciliary nerves. These are numerous fine filaments, which pass forward in close relation to the optic nerve, to pierce the posterior part of the sclera. (Fig. 16.)

The abducens nerve enters the orbit deeply and passes forward directly into the lateral rectus muscle, which it supplies .

The ophthalmic artery enters the orbit at the optic foramen, where it lies below the optic nerve. Winding around the lateral side of the optic nerve, and then crossing above it, it runs forward close to the medial wall of the orbit below the superior oblique muscle. It ends by dividing into two small branches, the frontal and the dorsal nasal, which emerge on to the face close to the infratrochlear nerve. In its course the ophthalmic artery gives rise to lacrimal, supraorbital, posterior ethmoidal, and anterior ethmoidal arteries, which accompany the nerves of the same name. In addition to these branches it supplies twigs to the ocular muscles, and a group of small ciliary arteries, which enter the eyeball.

Sever the optic nerve and draw it upward and forward to expose the inferior rectus. The origins of the various ocular muscles around the optic foramen may now be examined in detail, and they may be traced to their individual insertions on the eyeball. The inferior oblique muscle is best dissected from the front. It arises from the maxilla at the anterior medial angle of the floor of the orbit and passes laterally and backward, below the inferior rectus, to be inserted into the lateral part of the sclera, posterior to a plane dividing the eyeball into anterior and posterior halves.

PREVERTEBRAL REGION

Make on each side of the skull, a vertical cut with a saw, starting on the external surface about a quarter of an inch posterior to the mastoid process and passing forward and medially, to reach the postero-lateral end of the jugular foramen. Divide the oesophagus and the trachea transversely just below the level of the cricoid cartilage. Then turn the cranium upside down, so that its upper cut edge rests flat on the table, and, drawing the pharynx forward, separate it from the prevertebral muscles all the way up to the base of the skull. With a chisel make a transverse incision through the basilar portion of the occipital bone, between the pharynx and the prevertebral muscles. The chisel should be directed slightly posteriorly as it passes upward through the occipital bone. From either end of this transverse incision, again with the chisel, make an incision passing backward and laterally, to reach the anteromedial end of the jugular foramen. With a scalpel cut through any soft structures which may still hold the two parts together, and separate the anterior part of the skull with the attached pharynx, from the posterior part, which will remain with the vertebral column.

Review the attachments of the scalenus anterior. Clean the scalenus medius and scalenus posterior; these two muscles are not readily separable from each other except as they approach their insertions. The scalenus medius arises usually from the posterior tubercles of the transverse processes of the third to seventh cervical vertebrae, but frequently also receives slips from the first and second vertebrae. The various slips combine to a single muscle-belly, which is inserted into the upper border of the first rib behind the groove for the subclavian artery. The fibers of the scalenus posterior arise in common with the origin of the lower three or four slips of the scalenus medius, and are inserted into the lateral surface of the second rib. The two muscles are supplied by small twigs from the anterior rami of the fourth to the eighth cervical nerves.

The prevertebral muscles, which should now be cleaned, include the longus capitis and the longus colli. In relation to the anterior surfaces of these muscles is the prevertebral fascia, a fairly dense layer of the deep cervical fascia, which must be removed as the muscles are cleaned.

The longus capitis arises by four slips, from the anterior tubercles of the third, fourth, fifth, and sixth cervical vertebrae; running upward, the four

slips join to form a single flat belly, which is inserted into the basilar portion of the occipital bone. The upper slips of origin are partially hidden anteriorly by the main mass of the muscle, and can best be seen if the whole muscle is everted laterally. The longus capitis is supplied by twigs from the anterior rami of the first four cervical nerves.

The longus colli is a complex muscle, which is usually regarded for convenience of description as consisting of three parts; an upper oblique portion,

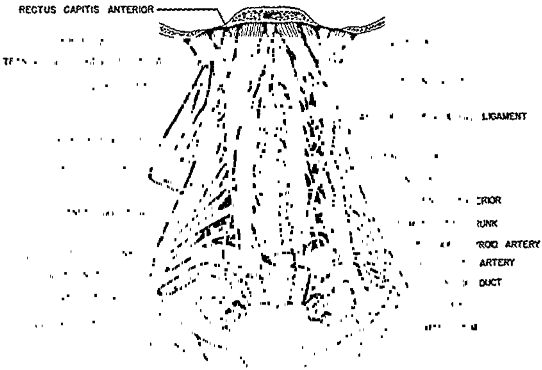

Fig. 17.—Dissection of the prevertebral region. The left longus capitis muscle has been everted laterally, to display its slips of origin

a middle vertical portion, and a lower oblique portion. It should be noted, however, that the three parts are continuous, and can not be entirely separated from one another. The upper oblique portion, which is partially covered anteriorly by the longus capitis, arises from the anterior tubercles of the third, fourth, fifth, and sixth cervical vertebrae, and is inserted into the anterior tubercle of the atlas. The vertical portion arises by tendinous slips from the sides of the bodies of the lower two cervical and the first three thoracic vertebrae, and is inserted by similar slips into the bodies of the second, third, and fourth cervical vertebrae. The fibres of the lower oblique portion arise in common with the lower slips of the vertical portion, from the first three thoracic vertebrae, and are inserted into the anterior tubercles of the transverse processes of the fifth and sixth cervical vertebrae. The longus

colli is supplied by twigs from the anterior rami of the second to the sixth cervical nerves.

Running upward from the upper border of the lateral part of the atlas to the basilar portion of the occipital bone are two small flat muscles, the rectus capitis anterior, and the rectus capitis lateralis. The anterior ramus of the first cervical nerve emerges between these two muscles, to turn downward in front of the transverse process of the atlas.

The anterior aspects of the transverse processes of the successive cervical vertebrae are connected by a series of small anterior intertransverse muscles. No particular study of these muscles need be made, but they should be cut away, to expose the course of the vertebral portion of the vertebral artery. The vertebral artery has already been seen to arise as a branch of the subclavian, and to run upward in front of the transverse process of the seventh cervical vertebra, to enter the costotransverse foramen of the sixth cervical vertebra. It continues its course vertically upward, passing through the costotransverse foramina of the upper six vertebrae. It then turns posteriorly and medially in the groove on the upper surface of the posterior arch of the atlas, and enters the cranial cavity at the foramen magnum. It is surrounded by a plexus of small veins, which unite inferiorly to form the vertebral vein. In its upward passage through the neck the vertebral gives rise to a series of small spinal branches which enter the vertebral canal at the intervertebral foramina.

Observe that the cervical nerves, as they emerge from the intervertebral foramina, pass behind the vertebral artery.

THE MOUTH AND PHARYNX

The interior of the mouth may be studied to better advantage in a living person than in the dissecting room subject. The cavity of the mouth is partially divided into two parts, the vestibule, and the mouth cavity proper. The vestibule is the narrow, cleft-like space which is bounded by the cheeks and lips externally, and the teeth and gums internally. The mouth cavity proper is bounded anteriorly and laterally by the teeth and gums; posteriorly it is continuous with the oral portion of the cavity of the pharynx. Both the vestibule and the mouth proper are lined with a layer of mucous membrane, which is interrupted only at the points where the teeth emerge from the gums. Anteriorly this mucous membrane becomes con-

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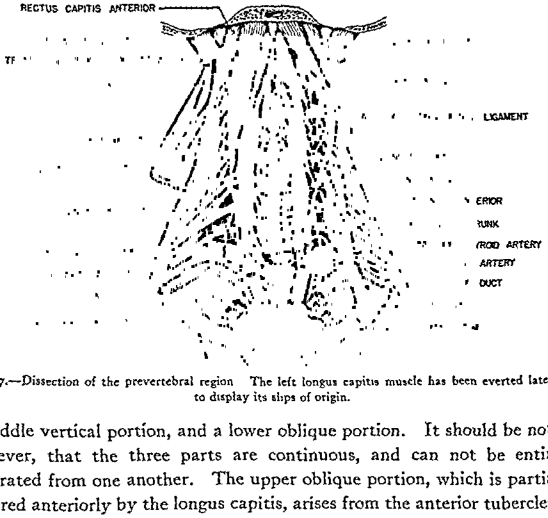

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tinuous at the lips with the skin of the face. Posteriorly it is continuous with the mucous membrane lining the pharynx. The parotid duct opens into the vestibule at the middle of the cheek.

The arched roof of the mouth is formed by the hard and soft palates. The actual boundary between the mouth and the pharynx is formed by the glossopalatine arches, which may be seen if the mouth is widely opened and the tongue depressed, extending upward on either side, from the side of the tongue to the under surface of the soft palate. Farther posteriorly, in the side wall of the pharynx, the pharyngopalatine arches may be seen. The space enclosed between the glossopalatine and the pharyngopalatine arches is known as the isthmus of the fauces, and is often spoken of as the passage of communication between the mouth and the pharynx, although it is itself actually a part of the pharynx. Within the side wall of the isthmus the palatine tonsil is lodged.

Projecting from the floor of the mouth is the tongue, which is also covered by the oral mucous membrane. Running from the under surface of the anterior free portion of the tongue to the floor of the mouth, observe a vertical fold of the mucous membrane; this is the frenulum linguae. At either side of the base of the frenulum the opening of the submaxillary duct may be seen at the summit of a small papilla. Extending posterolaterally along the floor of the mouth from the submaxillary opening is a low ridge, the plica sublingualis, caused by the presence immediately below the mucous membrane of the sublingual gland. At the summit of the plica, the minute orifices of the sublingual ducts may sometimes be recognized.

To prepare the pharyngeal wall for dissection, remove whatever may remain of the great vessels and nerves that are in relation to it laterally. It is advisable also completely to remove whatever may be left of the internal and external pterygoid muscles, leaving the lateral pterygoid plate bare. Then distend the pharynx by stuffing it, either from the mouth or from the oesophagus, or both, with cheesecloth, and clean the constrictor muscles in the wall of the pharynx.

The wall of the pharynx is composed of four layers. These are, from without inward, the bucco-pharyngeal fascia, the muscular layer, the pharyngeal aponeurosis, and the mucous membrane. The bucco-pharyngeal fascia, and with it the plexus of veins which it contains, are to be removed in cleaning the muscles. The principal muscles comprising the muscular

layer of the pharyngeal wall are the superior, middle, and inferior pharyngeal constrictors. The muscular layer is not entirely complete, and in regions where it is lacking the pharyngeal aponeurosis is particularly dense. The constrictors arise anterolaterally and spread posteromedially around the wall of the pharynx, to be inserted into a fibrous median raphe which represents a thickening of the pharyngeal aponeurosis along the posterior wall of the pharynx in the median line. Posteriorly, as they spread to their

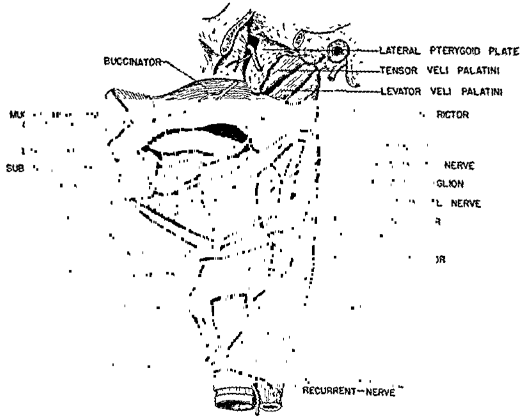

FIG. 18—Dissection to display the muscles of the pharyngeal wall, seen from the left side.

insertions, the constrictors overlap one another from below upward. It is therefore advisable to clean first the inferior constrictor.

The inferior pharyngeal constrictor is covered at its origin by the upper part of the sternothyroid muscle. It arises from the thyroid cartilage just behind the oblique line, from a fibrous arch bridging over the cricothyroid muscle between the thyroid and cricoid cartilages, and from the lateral surface of the cricoid. As it approaches its insertion in the median raphe, it spreads far superiorly, the upper fibres overlapping externally the insertion of the middle constrictor.

The middle constrictor arises from the upper border of the greater cornu and from the posterior border of the lesser cornu of the hyoid bone; it is

tinuous at the lips with the skin of the face. Posteriorly it is continuous with the mucous membrane lining the pharynx. The parotid duct opens into the vestibule at the middle of the cheek.

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municates freely anteriorly with the nasal cavities, the mouth, and the larynx. The cavity of the pharynx is lined by a mucous membrane which is continuous anteriorly with the mucous membranes lining the nasal cavities, the mouth, and the larynx. The cavity of the pharynx is divisible from above downward into three parts. These are the nasal pharynx, the oral pharynx, and the laryngeal pharynx.

The nasal portion of the pharynx lies below the body of the sphenoid and the basal portion of the occipital bone, and behind the nasal cavities, with

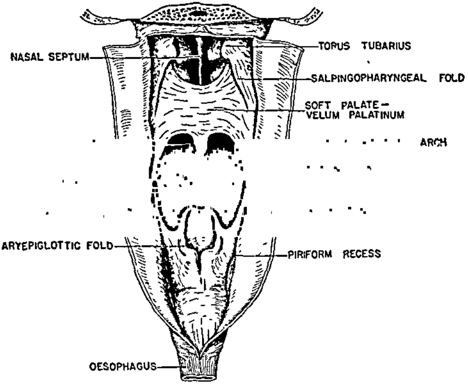

FIG. 19.—The interior of the pharynx, seen from behind.

which it communicates at the choanae. At the upper anterior part of the lateral wall of the nasopharynx on each side may be seen the opening of the auditory tube. This opening is bounded above and behind by a prominent ridge, the torus tubarius. A flexible probe introduced into this opening will pass laterally and backward into the cavity of the middle ear. Descending on the side wall of the pharynx from the torus tubarius is a slight fold of mucous membrane, which gradually disappears inferiorly; this is the salpingopharyngeal fold. Just behind the torus tubarius is a pocket-like depression in the lateral wall, the pharyngeal recess. In the posterior wall of the nasopharynx, between the two pharyngeal recesses, is a collection of lymphoid tissue known as the pharyngeal tonsil.

overlapped at its origin by the hyoglossus. Its fibres radiate toward their insertion on the median raphe, this insertion being almost entirely under cover of the inferior constrictor.

The superior constrictor arises from the lower part of the posterior border of the medial pterygoid plate, from the pterygomandibular raphe, and from the highest part of the mylohyoid line on the inner surface of the mandible. The pterygomandibular raphe is a fibrous band running from the pterygoid hamulus to the inner surface of the mandible, and serving to separate the fibres of the buccinator from those of the superior constrictor. The uppermost fibres of the superior constrictor reach as high as the pharyngeal tubercle of the occipital bone for their insertion; the remainder are inserted into the median raphe, under cover of the insertion of the middle constrictor.

In the lateral wall of the pharynx, above the curved superior border of the superior constrictor, the pharyngeal aponeurosis may be seen to be especially thick. In the anterior part of this small area, behind the pterygoid process, above the superior constrictor, and external to the pharyngeal aponeurosis, the upper portions of two of the muscles of the soft palate may be exposed. The more anterior of these is the tensor veli palatini. This is a narrow flat sheet of muscle which arises from the scaphoid fossa of the sphenoid bone and from the inferior surface of the auditory tube. Just posterior to the tensor is the levator veli palatini, which arises from the inferior surface of the petrous part of the temporal bone, in front of the carotid canal. The fibres of both muscles descend in the upper part of the lateral wall of the pharynx, to pass from view at present, deep to the upper border of the superior constrictor. (Fig. 18.)

The stylopharyngeus has already been seen to arise from the styloid process. It reaches the wall of the pharynx at the upper border of the middle constrictor. Passing downward, deep to that muscle, most of its fibres blend with the constrictors, though a few descend to gain an independent insertion on the thyroid cartilage.

Open the pharynx by a transverse incision in its posterior wall just below the base of the skull and a longitudinal incision along the line of the median raphe, remove the cheesecloth packing, and study the interior of the pharynx.

Observe that the wall of the pharynx is complete laterally and posteriorly, but that anteriorly it is very incomplete, since the pharynx com-

The principal muscles of the soft palate are the tensor veli palatini and the levator veli palatini, which raise the palate, and the glossopalatine and pharyngopalatine muscles, which depress it. Nearest to the superior surface of the palate are the pharyngopalatine and the levator. These two muscles should therefore be cleaned first.

The pharyngopalatine muscle is lodged in the pharyngopalatine fold. It arises on either side from the posterior border of the thyroid cartilage and from the pharyngeal aponeurosis in close relation to the inner surface of the inferior constrictor. Running upward into the soft palate, its fibres are inserted into the palatal aponeurosis in two strata, the superior of which crosses above the levator, and the inferior (and more anterior) below it.

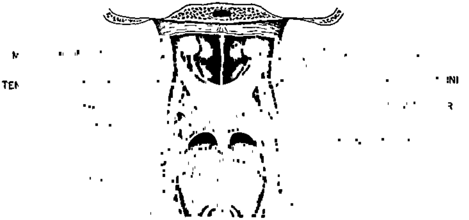

FIG. 20.—Dissection to display the muscles of the soft palate. The upper part of the pharyngopalatine muscle has been removed on the left side.

The origin of the levator veli palatini from the petrous part of the temporal bone has already been seen. Sweeping downward and medially into the soft palate, most of its fibres are inserted into the palatal aponeurosis near the median line; a few of them are continuous across the median line with fibres of the corresponding muscle of the opposite side.

The origin and upper portion of the tensor veli palatini have already been seen. To expose its insertion the palatal portions of the levator and of the pharyngopalatine must be removed. Passing downward from its origin, the belly of the muscle lies just lateral to the medial pterygoid plate. At the hamulus it becomes tendinous; the tendon turns medially under the hamulus, to enter the soft palate, and spreads out to be inserted directly into the palatal aponeurosis and into the posterior border of the hard palate.

The glossopalatine muscle arises from the side of the posterior part of the tongue. Its fibres ascend, in the glossopalatine fold, to reach the under

The soft palate projects backward and downward into the pharynx, separating the nasal from the oral portion. Below the soft palate, the glossopalatine arches separate the mouth from the oral portion of the pharynx. Inferiorly the posterior surface of the base of the tongue forms the anterior boundary of the oral pharynx. The pharyngopalatine arches appear as prominent folds on the lateral wall of the oral pharynx. Between the glossopalatine and pharyngopalatine folds on each side is an aggregation of lymphoid tissue, the palatine tonsil. The lingual tonsil is a similar, but more diffuse, aggregation of lymphoid tissue at the base of the tongue.

The laryngeal portion of the pharynx is a direct inferior continuation of the oral portion. In the upper part of its anterior wall is the epiglottis; below the epiglottis is the superior aperture of the larynx; below this aperture the anterior wall of the pharynx is formed by the mucous membrane in relation to the posterior aspect of the cricoid cartilage. The pharynx ends inferiorly at the level of the lower border of the cricoid cartilage, where it becomes continuous with the oesophagus. The laryngeal aperture (aditus laryngis) is bounded by the aryepiglottic folds. These are folds of the mucous membrane passing upward and forward from the arytaenoid cartilages (which may be felt but not seen through the mucous membrane), to the lateral borders of the epiglottis. Lateral to the lower part of the aryepiglottic fold on either side is a deep pocket in the pharyngeal wall, the recessus piriformis.

Attention should next be directed to the soft palate (velum palatinum). The soft palate is covered on both its superior and its inferior surfaces by a layer of mucous membrane. Anteriorly it is attached to the posterior border of the hard palate; posteriorly it presents a free margin, at the center of which is a conical projection, the uvula; laterally on either side the soft palate joins the lateral wall of the pharynx. The main bulk of the substance of the soft palate consists of muscle fibres, most of which are inserted into the palatal aponeurosis. The latter may be regarded as constituting the skeleton of the soft palate; it is a sheet of fibrous tissue which extends posteriorly into the soft palate from the bony margin of the hard palate. In order to expose the muscles of the soft palate it is necessary carefully to remove the mucous membrane from the superior surface of the soft palate and from the lateral wall of the nasal and oral portions of the pharynx.

of the septum, and the vessels and nerves which appear between the mucosa and the bone. In addition to the olfactory nerve, the septal mucosa receives nerves of general sensibility, which are derived from the ophthalmic and maxillary nerves. The anterior third of the septum is supplied by the medial nasal branch of the anterior ethmoidal nerve, which may be found descending on the deep surface of the anterior part of the septal mucosa, where it is accompanied by a small branch of the anterior ethmoidal artery. The posterior two thirds of the septum is supplied by the nasopalatine nerve. This nerve is described as a branch of the sphenopalatine ganglion, but is principally composed of afferent nerve-fibres derived from the maxillary nerve. It reaches the upper posterior part of the septum by crossing the posterior portion of the roof of the nasal cavity, and runs downward and forward between the mucosa and the bone of the septum, to reach the incisive canal, through which it passes to terminate in the mucosa of the anterior portion of the hard palate. It is accompanied by a branch of the spheno-palatine artery.

Cut away the septal mucosa, to expose the lateral wall of the right nasal cavity. The lateral wall, like the septal wall, is covered by a thick, spongy mucous membrane, which shows the same subdivision into olfactory and respiratory areas. By means of the superior, middle, and inferior nasal conchae, which project from the lateral wall, the nasal cavity is partially subdivided into several regions. The portion of the cavity lying in front of the conchae and communicating with the exterior at the nostril, is known as the atrium. The portion of the cavity lying below the superior concha and above the middle concha is the superior meatus. The middle meatus lies below the middle concha, and the inferior meatus below the inferior concha. The small portion of the cavity which lies above and behind the superior concha is known as the spheno-ethmoidal recess. The uninterrupted medial portion of the nasal cavity, with which the atrium, the three meatuses, and the spheno-ethmoidal recess are all in free communication, is known as the common meatus. Posteriorly, at the choana, the nasal cavity opens freely into the nasal portion of the pharynx.

When the conchae have been examined in position, they should be turned upward, or broken away from the lateral wall with forceps, to expose the various openings in the lateral wall which lie under cover of the conchae. In the lateral wall of the superior meatus will be seen one or more openings by

surface of the palatal aponeurosis, into which they are inserted. It is the most inferior of the various muscular strata of the soft palate.

NASAL CAVITIES

The tongue and larynx, together with any portions of the mandible which may remain, should now be removed from the upper portion of the skull. To do this, cut through the structures forming the lateral walls of the mouth and pharynx by a transverse incision starting anteriorly at the angle of the mouth. The tongue and larynx may then be wrapped in damp cloths and laid aside for future study. The upper portion of the skull is next to be divided into two parts, to open the nasal cavities. Cut through the soft palate with a scalpel, in a sagittal plane slightly to the left of the median line. Starting at the left nostril, divide the fleshy and cartilaginous portions of the left side of the nose in the same plane. Then complete the division by a saw-cut in the same plane, through the roof of the left nasal cavity and the hard palate. Study of the nasal cavity may then be made to best advantage on the right side of the divided skull.

Study the nasal septum. This is a bony and cartilaginous plate covered on each side by a layer of mucous membrane. It usually deviates somewhat to one side, most frequently the right. The mucous membrane of the septum, and of the nasal cavities in general, is thick and spongy, containing numerous small mucous glands. Its upper third is designated as the olfactory area, since it contains the minute filaments of the *olfactory nerves*, which enter the nasal cavity through the small openings in the cribriform plate of the ethmoid bone. The olfactory mucosa is thinner and less rich in glands than is the mucosa of the lower two thirds, or respiratory area of the septum.

Strip the mucous membrane from the left side of the septum and observe the bony and cartilaginous framework of the latter. The bony portion of the septum is formed principally by the vomer and the perpendicular plate of the ethmoid. Anteriorly the septum is completed by the septal cartilage. Anterosuperiorly the septal cartilage joins the suture between the two nasal bones. Posterosuperiorly it joins the anterior border of the perpendicular plate of the ethmoid, and posteroinferiorly the anterior border of the vomer.

With forceps, carefully remove, a bit at a time, the bony portion of the septum, to expose the deep surface of the mucous membrane of the right side

it enters the cranial cavity. Here, lying external to the dura, it crosses the cribriform plate of the ethmoid, and enters the nasal cavity through a foramen at the side of the crista galli. Descending in a groove on the inner surface of the nasal bone, it divides into medial nasal, lateral nasal, and external nasal nerves. The medial nasal branch is distributed to the anterior part of the nasal septum, as already noted. The lateral nasal supplies the anterior part of the lateral wall of the nasal cavity. The external nasal emerges between the nasal bone and the nasal cartilage, to reach the skin of the nose. The anterior ethmoidal nerve is accompanied in its distribution by the anterior ethmoidal branch of the ophthalmic artery.

MAXILLARY NERVE AND PTERYGOPALATINE FOSSA

The superior orbital fissure has already been opened from above in the dissection of the orbit. It should now be more widely opened by the removal, with a saw, of a wedge-shaped piece of bone from the anterior part of the wall of the temporal fossa. This piece of bone will include the great wing of the sphenoid and the anterior part of the squamous part of the temporal bone. The apex of the wedge should reach the superior orbital fissure just above and in front of the foramen rotundum; attempt to preserve intact the bony rim of the foramen rotundum. Then remove the periosteum of the orbit and any structures which may still remain within it, and trace out the course and distribution of the maxillary nerve.

Arising from the semilunar ganglion, the maxillary nerve passes forward in the lower part of the lateral wall of the cavernous sinus to the foramen rotundum. Here it leaves the cranial cavity and enters the upper part of the pterygopalatine fossa. Passing forward through the highest part of the pterygopalatine fossa, it bends laterally through the pterygomaxillary fissure, to enter the infratemporal fossa which it leaves almost at once by entering the posterior end of the infraorbital canal. From this point on it is known as the infraorbital nerve. The roof of the infraorbital canal should be removed with a chisel. Passing straight forward through the canal, which lies in the portion of the maxilla forming the floor of the orbit and the roof of the maxillary sinus, the infraorbital nerve emerges at the infraorbital foramen and breaks up under cover of the quadratus labii superioris into a number of cutaneous branches whose distribution has already been seen in the dissection of the face.

which the more posterior ethmoidal air cells communicate with the nasal cavity. Through these openings the nasal mucosa is continuous with the mucous membrane of the ethmoidal cells. The middle meatus is a considerably wider space than is the superior meatus. The portion of the middle meatus lying just below the anterior end of the middle concha leads upward into a closed passage known as the infundibulum, by which the frontal sinus communicates with the nasal cavity. Behind the infundibulum is a bulging prominence in the lateral wall known as the ethmoidal bulla, upon which the orifice connecting with the middle ethmoidal air cells will be seen. Running downward and backward from the infundibulum, below the ethmoidal bulla, is a curved groove, the hiatus semilunaris. In the hiatus will be seen the openings of the anterior ethmoidal air cells and of the maxillary sinus. In the wall of the inferior meatus is the opening of the naso-lacrimal duct, by which the tears are conveyed from the conjunctival sac into the nasal cavity. In the wall of the spheno-ethmoidal recess is the orifice by which the sphenoidal sinus communicates with the nasal cavity.

Observe that the sphenopalatine foramen, by which the nasal fossa communicates with the pterygopalatine fossa in a macerated skull, is not visible so long as the nasal mucosa is in place. The mucous membrane should now be stripped carefully away from the lateral wall of the nasal cavity, to expose the sphenopalatine foramen and the vessels and nerves which pass through it.

The nerves which enter the nasal cavity at the sphenopalatine foramen are the nasopalatine nerve and the posterior superior nasal nerves. All are branches of the sphenopalatine ganglion. The nasopalatine nerve, as already observed, crosses the roof of the nasal cavity to reach the septum. The posterior superior nasal nerves are small twigs, usually very difficult to demonstrate, which are distributed to the posterior part of the lateral wall of the nasal cavity. The sphenopalatine artery, a branch of the third part of the internal maxillary artery, also enters the nasal cavity at the sphenopalatine foramen. Its branches accompany the nerves in their distribution to both the lateral wall and the septum.

The anterior part of the lateral wall of the nasal cavity is supplied by the lateral nasal branch of the anterior ethmoidal nerve. This nerve has already been seen to arise in the orbit as one of the terminal branches of the nasociliary nerve. Leaving the orbit by way of the anterior ethmoidal foramen,

The medial branches pass through the sphenopalatine foramen to enter the nasal cavity. They include the posterior superior nasal nerves and the nasopalatine nerve, whose distribution has already been seen in the dissection of the nasal cavity. The descending branches are the palatine nerves. These, of which there are usually three, descend in the pterygopalatine canal to reach the palate. The mucous membrane should be carefully stripped away from the hard palate, to expose the distribution of these nerves. The largest of the palatine nerves is the great or anterior palatine nerve. Emerging at the greater palatine foramen, this nerve is distributed to the mucous membrane and glands of the hard palate. The middle and posterior palatine nerves are much smaller. Emerging at the lesser palatine foramina, they turn posteriorly into the soft palate.

The third part of the internal maxillary is very short. As it enters the pterygopalatine fossa the vessel breaks up almost immediately into its four terminal branches. These are the posterior superior alveolar, the sphenopalatine, the infraorbital, and the descending palatine arteries. The posterior superior alveolar artery may arise from the second part of the internal maxillary. It accompanies the posterior superior alveolar nerve in its distribution. The sphenopalatine artery enters the nasal cavity at the sphenopalatine foramen, and divides into branches whose distribution has already been observed. The infraorbital artery enters the infraorbital canal in company with the infraorbital nerve, and gives rise to small branches corresponding to the branches of that nerve. The descending palatine artery descends in the pterygopalatine canal, where it gives rise to two small palatine arteries, beyond which point it is known as the great palatine artery. The latter accompanies the anterior palatine nerve into the hard palate; the small palatine arteries are distributed to the soft palate with the middle and posterior palatine nerves.

With bone forceps attempt to open the pterygoid canal, to expose the nerve which traverses it. The nerve of the pterygoid canal is formed at the posterior end of that canal (which is at the anterior wall of the foramen lacerum) by the junction of the great superficial petrosal and the great deep petrosal nerves. The former is a branch of the facial nerve, which conveys preganglionic parasympathetic nerve fibres from the facial to the sphenopalatine ganglion. The great deep petrosal nerve is composed of postganglionic sympathetic fibres derived from the sympathetic trunk through

In the pterygopalatine fossa the maxillary nerve gives rise to two short thick sphenopalatine branches, which descend to join the sphenopalatine ganglion. They may best be seen somewhat later, when the pterygopalatine fossa has been opened from the medial side.

In the short portion of its course which lies in the infratemporal fossa the maxillary nerve gives rise to two branches, the zygomatic nerve, and the posterior superior alveolar nerve. The zygomatic nerve passes upward through the inferior orbital fissure to reach the lateral wall of the orbit, external to the periosteum. Here it divides into zygomatico-facial and zygomatico-temporal branches, both of which enter canals in the zygomatic bone, through which they reach the face, where their distribution has already been seen. The posterior superior alveolar nerve usually divides into two branches, both of which descend on the infratemporal surface of the maxilla, where they enter small canals in the bone, through which they are conveyed, in the lateral wall of the maxillary sinus, to the roots of the upper molar teeth.

In its passage through the infraorbital canal the infraorbital nerve gives rise to anterior and middle superior alveolar nerves, which pass through canals in the bony wall of the maxillary sinus, to be distributed to the upper incisor, canine, and premolar teeth. The superior alveolar nerves also supply the mucous membrane of the upper gums.

The pterygopalatine fossa should now be opened, by the removal, with a chisel, of the perpendicular plate of the palate bone. This bony plate lies in the posterior part of the lateral wall of the nasal cavity and separates the nasal cavity from the pterygopalatine fossa and the pterygopalatine canal with which the fossa is continuous inferiorly. In addition to the maxillary nerve, which crosses its highest part, the pterygopalatine fossa contains the sphenopalatine ganglion and the terminal part of the internal maxillary artery.

The sphenopalatine ganglion lies below the maxillary nerve and lateral to the sphenopalatine foramen. It receives from the maxillary nerve the two sphenopalatine nerves, which are described as the sensory roots of the ganglion. Posteriorly it receives the nerve of the pterygoid canal, described as its motor root. This nerve enters the fossa at the anterior end of the pterygoid canal. The principal branches which arise from the ganglion may be grouped as medial and descending branches.

The medial branches pass through the sphenopalatine foramen to enter the nasal cavity. They include the posterior superior nasal nerves and the nasopalatine nerve, whose distribution has already been seen in the dissection of the nasal cavity. The descending branches are the palatine nerves. These, of which there are usually three, descend in the pterygopalatine canal to reach the palate. The mucous membrane should be carefully stripped away from the hard palate, to expose the distribution of these nerves. The largest of the palatine nerves is the great or anterior palatine nerve. Emerging at the greater palatine foramen, this nerve is distributed to the mucous membrane and glands of the hard palate. The middle and posterior palatine nerves are much smaller. Emerging at the lesser palatine foramina, they turn posteriorly into the soft palate.

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the internal carotid plexus. It should be noted that the branches of the sphenopalatine ganglion consist very largely of sensory fibres derived from the maxillary nerve, through its sphenopalatine branches, but that they also contain the sympathetic postganglionics of the great deep petrosal nerve, and parasympathetic postganglionics derived from the ganglion itself.

THE LARYNX

Before starting the dissection of the larynx it is advisable to have a clear idea of its general plan of structure. A good model showing the laryngeal cartilages and their articulations is helpful in this. The cartilages which may be regarded as forming the skeleton of the larynx are the single thyroid and cricoid cartilages, and the paired arytenoid cartilages. The thyroid cartilage consists of two laminae, which are joined in the midline anteriorly at the laryngeal prominence. It is deficient posteriorly; the free posterior margin of each lamina is prolonged superiorly and inferiorly as the superior and inferior cornua, respectively, of the thyroid cartilage. The cricoid cartilage, which lies below the thyroid, and above the first ring of the trachea, forms a complete ring. This ring is relatively narrow anteriorly and laterally, but is expanded posteriorly to form a broad plate, the lamina of the cricoid. The medial surface of the tip of the inferior cornu of the thyroid cartilage articulates with the lateral aspect of the cricoid. The arytenoid cartilages are small, pyramidal cartilages resting, one on either side, upon the upper border of the cricoid lamina, with which they articulate by true diarthrodial joints. Each arytenoid cartilage exhibits a lateral prolongation, the muscular process, and an anterior prolongation, the vocal process. At its pointed apex, or superior process, the arytenoid cartilage articulates with a small cartilaginous nodule, the corniculate cartilage, which lies within the aryepiglottic fold.

The cartilages of the larynx are connected with one another by means of ligaments and muscles. The most important of the ligaments is the conus elasticus. This is a membranous ligament whose inferior margin is attached to the upper border of the anterior and lateral parts of the cricoid cartilage; its superior margin is attached anteriorly to the inner surface of the thyroid, and posteriorly to the vocal process of the arytenoid. Between these two attachments the conus elasticus presents a free superior border, which is

known as the vocal ligament. The vocal ligament lies internal to the lamina of the thyroid cartilage and is enclosed within the vocal fold of the laryngeal mucous membrane.

If any portions of the mandible still remain attached to the sides of the tongue they should be cut away. Remove also any portions of the sternothyroid, thyrohyoid, and inferior constrictor muscles which are still attached to the lamina of the thyroid cartilage. Clean the thyrohyoid membrane. This is a membranous ligament which extends from the upper border of the thyroid cartilage to the lower border of the body and greater cornu of the hyoid bone. The thyrohyoid membrane is pierced on each side by the internal laryngeal nerve and the superior laryngeal artery. It is strongest at its free posterolateral border, which runs from the superior cornu of the thyroid to the greater cornu of the hyoid, and in which a small cartilaginous nodule, the triticeate cartilage, is sometimes found.

Study the interior of the larynx as it may be seen through the superior laryngeal aperture. The larynx is clothed internally by a layer of mucous membrane, which is continuous superiorly with the mucous membrane of the pharynx and inferiorly with that of the trachea. The cavity of the larynx begins above at the aryepiglottic folds. From above downward it is partially subdivided into three compartments by the presence of two pairs of transverse folds in its lateral walls. The upper of these folds are the ventricular folds, or false vocal cords. Below these are the vocal folds, or true vocal cords, which may be readily seen from above, since they project farther medially than do the ventricular folds. The highest compartment of the laryngeal cavity is known as the vestibule of the larynx; it lies behind the epiglottis and above the ventricular folds. The portion of the laryngeal cavity lying between the ventricular folds and the vocal folds is known as the ventricle of the larynx. The ventricle communicates below, by means of the rima glottidis, with the inferior compartment of the larynx. The rima glottidis is the narrow interval between the two vocal folds. The inferior compartment widens out inferiorly to become directly continuous with the trachea.

Attention should next be directed to the muscles of the larynx. By moving the arytenoid cartilages upon the cricoid cartilage, or by changing the relative positions of the cricoid and thyroid cartilages, these muscles act to tense or relax, to approximate or to separate, the vocal cords.

Clean first the cricothyroid muscle. This muscle arises from the ant lateral part of the arch of the cricoid. Running upward and backward fibres radiate slightly, to be inserted on the lower border and inferior co of the thyroid cartilage. It is supplied by the external branch of the supe laryngeal nerve. (See Fig. 18.)

Turn to the posterior aspect of the larynx, and remove the muc membrane forming the anterior wall of the pharynx below the superior lar geal aperture. Then clean the posterior cricoarytenoid and the aryten

Fig. 21.—Posterior aspect of the larynx, after removal of the pharyngeal mucosa.

muscles. As the mucous membrane is removed, identify and retain position the inferior (recurrent) laryngeal nerve, which ascends on t posterior aspect of the larynx in close relation to the external surface of t pharyngeal mucosa.

The posterior cricoarytenoid muscle arises on each side from t *posterior aspect of the cricoid lamina. Its fibres converge upward a* laterally, to be inserted on the muscular process of the arytenoid cartilag The arytenoid muscle is a single median muscle, whose fibres take origin c the posterior surface of one arytenoid cartilage and are inserted into th posterior surface of the other. It is roughly divisible into transverse an oblique portions. The oblique fibres of each side arise from the posterio aspect of the muscular process of the arytenoid cartilage and run upwar *and medially, to cross the median line and reach the apex of the arytenoi* cartilage of the opposite side. A few of them are prolonged forward withi the aryepiglottic fold to the epiglottis, as the aryepiglottic muscle.

Turn to the lateral aspect of the larynx. Sever the attachment of the thyrohyoid membrane to the thyroid cartilage on one side, and disarticulate the inferior cornu of the thyroid from the cricoid. Detach the cricothyroid muscle from its origin on the cricoid cartilage. Then cut through the lamina of the thyroid cartilage vertically on the same side about a quarter of an inch posterolateral to the median line, and remove the lamina. Clean the lateral cricoarytenoid and the thyroarytenoid muscles. (Fig. 22.)

The lateral cricoarytenoid muscle arises from the upper border of the lateral part of the cricoid arch. Its fibres run upward and backward and converge to an insertion on the muscular process of the arytenoid cartilage. The thyroarytenoid muscle is variable in the extent of its development and

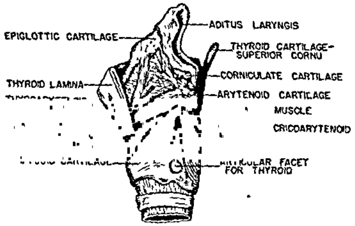

FIG. 22.—Dissection of the larynx, seen from the left side. The greater part of the left lamina of the thyroid cartilage has been removed.

frequently appears to be continuous with the upper border of the lateral cricoarytenoid. Its essential and constant portion is the vocal muscle, which extends from the inner surface of the angle of the thyroid laminae to the arytenoid cartilage. It lies within the vocal fold, just lateral to the vocal ligament.

The muscles of the larynx, with the exception of the cricothyroid, are supplied by the inferior (recurrent) laryngeal nerve. Ascending in the groove between the trachea and the oesophagus, this nerve divides at the lower border of the cricoid cartilage into an anterior and a posterior branch. The posterior branch ascends on the posterior cricoarytenoid, to supply that muscle and the arytenoid muscle. The anterior branch runs forward and upward, to supply the lateral cricoarytenoid and the thyroarytenoid.

The internal laryngeal nerve is the sensory nerve of the larynx. Having pierced the thyrohyoid membrane, it reaches the deep surface of the laryngeal mucosa, in relation to which it ramifies. (Fig. 21.)

Carefully remove the lateral cricoarytenoid and the thyroarytenoid muscles and attempt to display the conus elasticus, which runs upward and medially, deep to these two muscles, from the upper border of the arch of the cricoid. Observe that its free upper border, the vocal ligament, lies within the vocal fold, where it is lateral to the mucous membrane, and medial to the vocal muscle. The vocal ligament is attached anteriorly to the inner surface of the thyroid cartilage and posteriorly to the vocal process of the arytenoid cartilage.

THORACIC WALL

For the dissection of the thoracic wall and thoracic cavity the body lies supine. The superior extremities and their girdles will have been removed previously. Any remnants of the serratus anterior or pectoral muscles which may remain attached to the thoracic wall should be completely removed, to expose the external aspects of the ribs, costal cartilages and sternum, and the external intercostal muscles. Attempt to find the cut ends of the lateral cutaneous branches of the intercostal nerves. These nerves emerge through the external intercostal muscles near the attachment of the digitations of the serratus anterior muscle and run downward and forward to be distributed to the skin on the lateral and antero-lateral aspect of the trunk.

The bony wall of the thorax is made up by the thoracic vertebrae, the sternum, and the twelve pairs of ribs and their costal cartilages. The spaces between the ribs, known as the intercostal spaces, are filled by the external and internal intercostal muscles. In these spaces also will be found the intercostal nerves and the intercostal blood vessels. The dissection of the thoracic wall is made difficult by the fact that the ribs in the dissecting room subject are usually in the position of complete expiration, which greatly decreases the width of the intercostal spaces. This is especially true in the case of the lower spaces, so that for detailed study of the intercostal structures, one of the upper spaces will be found most favorable.

Study the external intercostal muscles. These are eleven pairs of thin muscular sheets whose fibres run downward and forward around the thoracic wall. Each takes origin from the inferior border of a rib and is inserted on

the superior border of the next rib below. Posteriorly the external intercostals begin at the tubercles of the ribs, but this fact can not well be demonstrated now. Anteriorly they extend only so far as the junctions of the ribs with their costal cartilages. Between the cartilages the muscle is replaced by a membranous layer, the anterior intercostal membrane, through which the fibres of the internal intercostal muscle are usually visible. Divide the external intercostal muscle and the anterior intercostal membrane along the upper border of the rib in one or two spaces and turn them upward, to expose the internal intercostal muscle.

The internal intercostal muscles also occur in eleven pairs. Their fibres run downward and backward. Each takes origin from the inner surface of a rib, at the upper border of the costal groove when the groove is present, and is inserted at the upper border of the next rib below, close to the insertion of the corresponding external intercostal muscle. The costal groove is thus enclosed by the two layers of intercostal muscle. Posteriorly the internal intercostals extend only to the angles of the ribs; anteriorly they reach the lateral border of the sternum.

The intercostal nerves and vessels are situated for the greater part of their course in the costal grooves and hence under cover of the lower borders of the ribs. For their display it is usually necessary to chip away the lower part of the rib, but this must be done with care to avoid injury to the nerves and vessels. Unless they happen to be exceptionally well injected, it is usually impossible to achieve a satisfactory demonstration of the intercostal arteries in the ordinary dissecting room subject.

The intercostal nerves are the anterior rami of the first eleven pairs of thoracic nerves. Their proximal segments will be seen in the dissection of the thoracic cavity. In the present dissection, one or two of them should be exposed in the costal groove as far posteriorly as can conveniently be reached, and traced anteriorly. In the costal groove the nerve lies between the external and internal intercostal muscles, to each of which it gives twigs of supply. Each intercostal nerve gives rise to a relatively large lateral cutaneous branch, which pierces the external intercostal muscle. As the trunk of the intercostal nerve is traced anteriorly it will be found to enter the substance of the internal intercostal muscle a little in front of the mid-axillary line. Near the junction of the rib and costal cartilage it reaches the deep surface of the muscle. From this point it runs forward between the internal

intercostal muscle and the pleural membrane or the transversus thoracic muscle, which it also supplies; near the lateral border of the sternum it bends anteriorly and pierces the internal intercostal muscle, the anterior intercostal membrane, and the pectoralis major muscle, to end superficially as an anterior cutaneous nerve of the chest. This description holds good, as regards the terminal parts of the nerves, only for the upper five; the lower six intercostal nerves, after reaching the anterior ends of the intercostal spaces, run downward and forward into the anterior abdominal wall, where their distribution will be investigated when the abdominal wall is dissected.

The intercostal arteries occur in two paired groups, known as the anterior and the posterior intercostal arteries. The posterior intercostal arteries of the first two spaces are derived from the superior intercostal artery, a branch of the costocervical branch of the subclavian artery. The remaining nine pairs of posterior intercostals are direct branches of the thoracic aorta. *These vessels will all be seen without difficulty in the final stages of the dissection of the thoracic cavity.* In the lateral and anterior portions of the thoracic wall now under observation, they are, as noted above, usually impossible of satisfactory demonstration. They run forward in the costal groove, giving numerous small twigs for the supply of the intercostal muscles. The anterior intercostal arteries are small vessels, usually two to each space, which run posteriorly in the anterior parts of the intercostal spaces, and end by anastomosing with the terminal twigs of the posterior intercostals. The anterior intercostals of the upper five spaces are branches of the internal mammary artery; those of the lower six spaces are branches of the musculophrenic artery.

The internal mammary artery should be exposed by removing the internal intercostal muscles in the upper five spaces for about an inch lateral to the sternum. This artery arises in the neck as a branch of the first part of the subclavian artery. It enters the thorax by passing downward behind the sternoclavicular joint, and runs down in the anterior thoracic wall behind the first five costal cartilages, between which it may now be seen, usually accompanied by two veins. In the upper two spaces, it lies between the internal muscles and the pleura; lower down it is separated from the pleura by slips of the transversus thoracic muscle. The internal mammary artery ends behind the sixth costal cartilage by dividing into the superior epigastric and the musculophrenic arteries.

The transversus thoracis is a small muscle of the anterior thoracic wall, of which only a very imperfect view can be obtained at present. It arises from the posterior surface of the lower half of the body and the xiphoid process of the sternum. From this origin flat fibrous bands run upward and laterally to be inserted on the posterior surfaces of the third to sixth costal cartilages. It can be seen to best advantage when the sternum and costal cartilages are removed to open the thoracic cavity.

THORACIC CAVITY

Before opening the thoracic cavity it is well to have a clear idea of the general plan of its contents. The thoracic wall, which has already been studied, is made up of the twelve thoracic vertebrae, twelve pairs of ribs and their costal cartilages, the sternum, the external and internal intercostal, and the transversus thoracis muscles. In the wall are found also the intercostal vessels and nerves, and in close relation to the inner surface of the anterior part of the wall the internal mammary vessels.

Through the superior thoracic aperture, which is bounded by the upper border of the manubrium sterni, the first pair of ribs and their cartilages, and the upper border of the first thoracic vertebra, the thoracic cavity communicates freely with the root of the neck. Inferiorly the thoracic cavity is separated from the abdominal cavity by a sheet of muscular and fibrous tissue, the diaphragm.

The inferior thoracic aperture is more irregular in outline and of much greater diameter than is the superior aperture. It may be shown on the skeleton by a line beginning at the lower border of the twelfth thoracic vertebra, and passing around on each side along the lower border of the twelfth rib, thence to the tip of the eleventh rib, the lowest part of the tenth costal cartilage and along the continuous lower margins of the ninth, eighth and seventh costal cartilages, to the xiphoid process. This line will indicate approximately the line of origin of the muscle fibres which make up the peripheral portion of the diaphragm. The diaphragm does not, however, bridge across this aperture in a transverse plane, but is dome-shaped, its central portion reaching a considerably higher lever than its peripheral attachment, thus permitting the abdominal cavity to be enclosed within the lower part of the thoracic skeleton.

The contents of the thoracic cavity may be inclusively described as consisting of two pleural sacs, in each of which a lung is contained, and the mediastinum. The pleural sacs are laterally placed, lying internal to the ribs and intercostal muscles, while the mediastinum is the middle portion of the thoracic contents, lying between the two pleural sacs, in relation to the sternum anteriorly and the bodies of the vertebrae posteriorly.

Each pleural sac is a completely enclosed cavity, which is almost entirely filled by the lung. The two pleural cavities are nowhere in communication with each other. Each pleural cavity is bounded by a serous membrane, the pleura. The lung projects into the pleural cavity from the medial side, where it is attached to the mediastinum by a short, roughly circular stalk known as the root of the lung. The pleura or pleural membrane forms not only the outer wall of the pleural sac, but is also continued over the root of the lung to form the external covering of the lung itself, so that the lung may be regarded as having been laterally invaginated into the pleural sac from its root, and as having pushed the pleura before it, as it invaginated. Each pleura is one continuous membrane, but from its relations to the lung and to the thoracic wall each pleura is regarded as consisting of two portions. These are the visceral pleura—that portion which forms the external covering of the lung itself, and the parietal pleura—that portion which forms the outer wall of the pleural cavity. These two portions are directly continuous with each other around the root of the lung. The parietal pleura is further subdivided into three parts, according to its relations to the thoracic wall. These are the costal, the diaphragmatic, and the mediastinal pleurae. The costal pleura forms the continuous curved anterior, lateral and posterior walls of the pleural cavity and it is in direct relation externally to the internal surfaces of the ribs and intercostal muscles. The diaphragmatic pleura forms the inferior boundary of the cavity; it is closely applied to the superior surface of the diaphragm and is continuous at the peripheral attachment of the diaphragm with the costal pleura. The mediastinal pleura forms the medial boundary of the pleural cavity and is in relation medially to the mediastinum. It is continuous inferiorly with the diaphragmatic pleura and anteriorly, posteriorly, and superiorly with the costal pleura. It is also the portion of the parietal pleura which is directly continuous over the root of the lung with the visceral pleura. The uppermost, dome-shaped portion of the costal pleura, which extends some distance

above the level of the first rib into the root of the neck, is sometimes referred to as the cervical pleura.

It should be understood that the mediastinum is not a single anatomical entity, but is rather an anatomical concept which is of use for descriptive and reference purposes. The term mediastinum is applied to the entire complex of structures which lie between the right and left mediastinal pleurae, extending from the superior thoracic aperture above to the diaphragm below, and from the posterior surface of the sternum to the anterior surfaces of the thoracic vertebral bodies. The mediastinum thus includes within its confines some of the most important structures of the body. The mediastinum is further arbitrarily subdivided into parts. The structure on which this subdivision is based is the pericardium, the serous membrane which encloses the heart and parts of the vessels which join it. The mediastinum is divided into superior and inferior parts by an oblique plane passing from the lower border of the manubrium sterni backward and upward to the lower border of the fourth thoracic vertebra, this being the plane which indicates the highest extent of the pericardium. The superior mediastinum or portion of the mediastinum lying above this plane, contains the arch of the aorta and its branches, the innominate veins, the upper part of the superior vena cava, the lower part of the trachea, parts of the oesophagus, thoracic duct, and azygos vein, and numerous smaller structures. The inferior mediastinum, that portion of the mediastinum lying below the dividing plane, contains the pericardium and is further divided with reference to that structure, into the anterior mediastinum, the middle mediastinum, and the posterior mediastinum. The middle mediastinum is coextensive with the pericardium and consequently includes that membrane and the structures enclosed within it. The anterior mediastinum lies anterior to the pericardium and is of very slight extent. The posterior mediastinum lies posterior to the pericardium and contains the descending aorta, parts of the bronchi, pulmonary arteries and veins, azygos and hemiazygos veins, thoracic duct and oesophagus. The roots of the lungs join the upper part of the posterior mediastinum on each side.

In the present dissection the thorax cavity is to be opened from the front by the removal of the anterior and lateral portions of its wall, without injury to the underlying parietal pleura. The intercostal muscles should be removed from two or three of the upper spaces on each side as far laterally

as the mid-axillary line. This must be done with care, as the pleura is separated from the internal surface of the internal intercostal muscles only by a very thin fibrous layer, the endothoracic fascia. The fingers may now be introduced between the ribs and a gentle pressure will suffice to separate the pleura from the internal surfaces of the ribs. The separation must be continued as far inferiorly as the eighth rib. The procedure is facilitated by the section and removal of parts of the ribs as the dissection proceeds. The first rib should be left intact for the present, but the second through the seventh ribs on each side should be sectioned at their junctions with their costal cartilages and again in the mid-axillary line, and the pieces thus detached should be removed along with whatever remnants of the intercostal muscles may be still attached to them. When this has been done the external surface of the costal portion of the parietal pleura will be seen extending as a continuous membrane within the thoracic wall. The fingers should now be passed medially along this surface, behind the costal cartilages and the sternum, on first one side and then the other, and the pleura separated as completely as possible from this portion of the thoracic wall. The manubrium sterni should now be cut transversely with a saw, just below its junction with the first costal cartilage. Make another transverse cut through the lower part of the sternum, between its junction on either side with the sixth and the seventh costal cartilages, and then remove the portion of the sternum between the two cuts, together with the attached second through sixth costal cartilages. The xiphoid process and the seventh costal cartilages must be left in place in order not to injure the diaphragm. If the lower part of the neck has not yet been dissected the upper part of the manubrium and the first costal cartilages must be left in place throughout the thoracic dissection. If, however, this dissection has been done, the first ribs may be cut at their junctions with their costal cartilages and the manubrium and cartilages removed.

The anterior lines of reflection of the right and left pleurae should next be observed. These are the lines along which the costal pleura of each side turns back to become the mediastinal pleura. In a subject with little fat these lines may be at once apparent but in an obese subject they will be hidden by a considerable amount of adipose tissue, which must be removed. In such a case it will be found helpful to make a small opening in the costal pleura an inch or two lateral to the midline. The handle of the scalpel may

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then be introduced through the opening and passed medially along the internal surface of the pleura. Its medial passage will be stopped when it reaches the line of reflection of the pleura. In the region of the superior mediastinum, which lies behind the manubrium sterni, the two pleural margins diverge from each other and are lost to view at present behind the

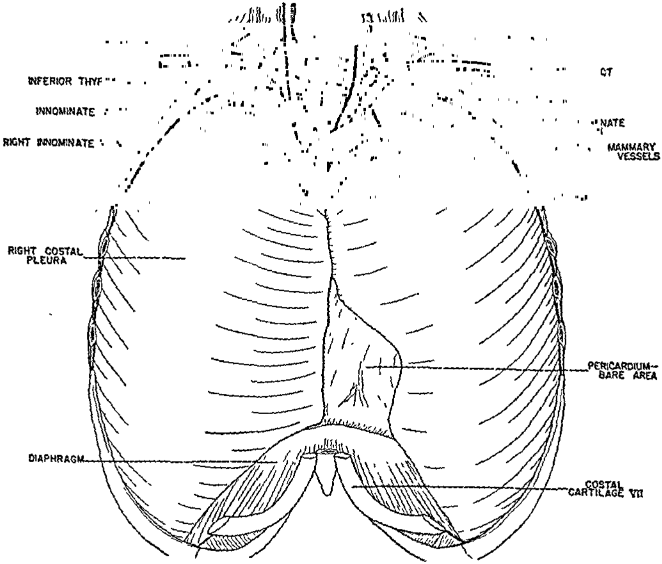

FIG. 23.—The thoracic cavity, opened by the removal of the anterior thoracic wall. Showing the anterior lines of pleural reflection.

innominate veins. At about the level of the lower border of the manubrium, they approach each other, and indeed frequently overlap to a slight extent in the midline. The right pleural margin passes vertically downward from this point, behind the middle of the sternum, to about the level of the sixth intercostal space, where it turns laterally and inferiorly across the diaphragm and can now be followed only as far as the junction of the eighth rib with

its costal cartilage. Along this inferior part of the margin the costal pleura becomes continuous with the diaphragmatic pleura. From the lower border of the manubrium, the left pleural margin passes vertically downward close to the right, to about the level of the fourth costal cartilage; from this point it diverges for a varying distance to the left. Inferiorly it crosses the diaphragm in a similar manner to the right. Between the two pleural margins in the region where the left reflection diverges to the left, the anterior surface of the pericardium is exposed. This is known as the bare area of the pericardium, and varies in its extent in different individuals. The pericardium will be seen to be attached to the diaphragm inferiorly. Between the inferior divergent margins of the pleura, and the lower border of the pericardium a considerable portion of the diaphragm, which is covered by neither pleura nor pericardium, is now exposed. The origin of the muscle fibres which make up this part of the diaphragm, from the xiphoid process and the seventh and eighth costal cartilages may now be seen.

Before proceeding to a study of the mediastinum, the pleural sacs should be opened. Make a longitudinal incision through the costal pleura from the level of the first to the eighth rib on each side. From either end of the longitudinal incisions, transverse incisions should be made laterally and medially, and the folds of pleura thus mapped out should be reflected to expose the pleura cavities and the lungs within them. During life the lungs entirely fill the pleural sacs, except for a very small interval, the pleural cavity, intervening between the external surface of the lung and the internal surface of the parietal pleural membrane, which contains a small amount of watery fluid. In the dissecting room subject, as soon as the parietal pleura is opened, the pressure of the entering air causes the lungs to shrink and the relative size of the pleural cavity is thereby increased.

The collapsed lungs may now be seen within the cavities. They are usually a bluish grey in color with dark patches scattered over their surface. The lungs themselves will be studied after they have been removed from the body. The external relations of the lungs may be understood by a study of the walls of the pleural cavities, which may now be explored with the fingers. In a perfectly normal and healthy pleural cavity, the visceral pleura, which is closely adherent to the outer surface of the lung and may be regarded as a part of the lung, is connected to the parietal pleura only by its continuity with the latter across the root of the lung and the pulmonary

ligament. Perfectly healthy lungs are, however, relatively rare in the dissecting room, and numerous secondary adhesions between the visceral and parietal pleurae will usually be found. In cases of long standing disease these adhesions may be so firm and so extensive as to render exploration of the pleural cavity impossible, but in many cases they may be readily broken down with the fingers. Exploration of the pleural cavities should then be made, to reveal the following facts.

The costal portion of the pleura is in intimate relation throughout with the inner surfaces of the ribs and intercostal muscles. Its most posterior extent is along the angles of the successive ribs, from which it is continued medially and forward across the lateral aspect of the bodies of the thoracic vertebrae, which may be readily felt through the pleura, to become continuous anteriorly with the mediastinal pleura. The uppermost portion of the pleura is dome-shaped and reaches up into the root of the neck some distance above the level of the first rib. This apical, or cervical portion of the pleura is crossed anteriorly a short distance below its summit by the subclavian artery, which can usually be felt through the pleura; it is separated from the subclavian vein by the first rib and the insertion thereon of the scalenus anterior muscle. Along its inferior margin the costal pleura is reflected upwards on to the diaphragm as the diaphragmatic pleura. From the junction of the eighth rib with its costal cartilage, to which it has already been traced, this pleural margin crosses the thoracic wall along a line slightly convex downward, which reaches approximately the level of the ninth rib in the mid-axillary line and the eleventh in the scapular line. The lateral and posterior portions of the periphery of the diaphragm extend almost vertically upward from this line, so that the lowest portion of each pleural cavity is a pocket-like cleft between the lowest part of the costal pleura and the peripheral part of the diaphragmatic pleura. Even during complete inspiration the inferior lateral border of the lung does not reach so low as the base of this cleft, which is known as the phrenicocostal sinus. The narrow antero-medial prolongation of each pleural cavity to the midline at the edge of which the costal pleura is reflected back to become the mediastinal pleura is known as the costo-mediastinal sinus.

The diaphragmatic pleura is closely applied to the superior surface of the diaphragm, whose contour it follows exactly. On the right side the hard mass of the liver may be felt through the diaphragmatic pleura and the

its costal cartilage. Along this inferior part of the margin the costal pleura becomes continuous with the diaphragmatic pleura. From the lower border of the manubrium, the left pleural margin passes vertically downward close to the right, to about the level of the fourth costal cartilage; from this point it diverges for a varying distance to the left. Inferiorly it crosses the diaphragm in a similar manner to the right. Between the two pleural margins in the region where the left reflection diverges to the left, the anterior surface of the pericardium is exposed. This is known as the bare area of the pericardium, and varies in its extent in different individuals. The pericardium will be seen to be attached to the diaphragm inferiorly. Between the inferior divergent margins of the pleura, and the lower border of the pericardium a considerable portion of the diaphragm, which is covered by neither pleura nor pericardium, is now exposed. The origin of the muscle fibres which make up this part of the diaphragm, from the xiphoid process and the seventh and eighth costal cartilages may now be seen.

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pleura is in relation to the oesophagus, which here lies immediately in front of the vertebral column. Since the oesophageal wall is composed of soft muscular tissue and is usually flattened against the vertebrae, it is difficult to recognize it by touch through the pleura. Below the posterior part of the azygos arch and behind the root of the lung, the oesophagus is again in relation to the pleura. If the vertical part of the azygos vein is of good size and well filled with blood, it also may be felt here behind the oesophagus. In the lower part of the posterior mediastinum the oesophagus inclines sharply toward the left and in this region the right pleural cavity often projects to the left of the midline in front of the bodies of the vertebrae. A ridge caused by the presence of the right phrenic nerve, which traverses the mediastinum immediately subjacent to the mediastinal pleura, can usually be seen. The nerve is in relation above to the innominate vein and superior vena cava and below to the right atrium and the pericardium. It is not always apparent through the pleura.

On the left side also the mediastinal pleura is in relation below and anteriorly to the heart and pericardium, but it will be seen that the heart projects much farther toward the left than it does to the right with the result that the capacity of the left pleural cavity is considerably less than is that of the right. The left surface of the heart is formed principally by the left ventricle, but its most superior and anterior part is formed by the conus arteriosus of the right ventricle, while the left atrium also contributes slightly to it. Above the root of the lung in a position similar to that of the azygos arch on the right side, but occupying a much wider area, the arch of the aorta can be easily felt through the pleura. Continuous with the posterior part of the arch and coursing vertically downward behind the root of the lung and the pulmonary ligament, with a slight inclination to the right below, the descending aorta will be felt. Running upward from the arch the left subclavian artery is in relation to the pleura, with the left innominate vein in front of it and the trachea behind it. Behind the trachea is the oesophagus. The oesophagus comes into relation with the left mediastinal pleura again in its lowest part, where the oesophagus projects to the left in front of the descending aorta just before its passage through the diaphragm. The left phrenic nerve usually makes a low ridge in the left mediastinal pleura which crosses from above downward the innominate vein, the arch of the aorta, and the heart and pericardium.

diaphragm. On the left side less resistance will be felt, due to the presence of the hollow stomach immediately below the diaphragm.

The contour and relations of the mediastinal pleura are not entirely alike on the two sides. On each side, however, the root of the lung will be seen connecting the lung to the posterior part of the mediastinum at about the level of the fifth to seventh thoracic vertebrae. The visceral pleura covering the lung is reflected across the root to become continuous with the mediastinal pleura. Anteriorly, superiorly and posteriorly the pleura is closely applied to the root of the lung, but inferiorly it is prolonged downward to form a membranous structure known as the pulmonary ligament. The pulmonary ligament is a double fold of pleura, which with the lung root itself, helps to hold the lung in place against the mediastinum. It consists of two layers of pleura with a small amount of fatty areolar tissue between them. These layers of pleura are continuous laterally with the visceral pleura on the inferior part of the mediastinal surface of the lung, superiorly with the pleura on the lung root, and medially with the mediastinal part of the parietal pleura. Inferiorly they are continuous with each other and present a free margin stretching transversely across the pleural cavity a short distance above the diaphragm. This lower free margin is often obscured by the presence of secondary adhesions between the pulmonary ligament and the diaphragmatic pleura. For the further study of the mediastinal pleura, the two sides must be considered separately.

On the right side, in front of the root of the lung and the pulmonary ligament, the right lateral surface of the heart may be felt through the mediastinal pleura. This surface of the heart is composed almost entirely of the right atrium, which is here separated from the pleura only by the pericardium. Immediately above the diaphragm and in front of the lowest part of the pulmonary ligament the inferior vena cava may be felt, where it traverses the diaphragm to enter the right atrium of the heart. Running upward from the atrium, in front of the upper part of the root the superior vena cava may be felt, and directly continuous with, this running up to the superior thoracic aperature, the right innominate vein. The arch of the azygos vein, which opens into the posterior aspect of the upper part of the superior vena cava may be felt immediately above the root of the lung. Above the azygos arch and behind the right innominate vein, the right mediastinal pleura is in contact with the trachea. Behind the trachea, the

pericardium, but its antero-posterior extent is very slight and it contains no structures of importance. Occasionally the remains of the thymus gland reach down into the upper part of the anterior mediastinum, between the two pleurae. (Fig. 23.)

The middle mediastinum is the portion of the inferior mediastinum which contains the pericardium. The only important structures of the middle mediastinum which are not enclosed within the pericardium are the two phrenic nerves and the blood vessels which accompany them. These descend on each side immediately in front of the roots of the lungs between the mediastinal pleurae and the parietal pericardium. The middle mediastinum cannot be fully investigated until the pericardial cavity is opened. Attention should now be directed to the superior mediastinum.

The superior mediastinum lies above the pericardium, and between the upper portions of the two mediastinal pleurae, extending from the posterior surface of the manubrium sterni to the anterior surfaces of the upper four thoracic vertebrae. Through the superior thoracic aperture it is in communication with the root of the neck, and the structures which connect the thoracic cavity with the neck will be found in this part of the mediastinum. To expose the anterior surface of the pericardium and to render the superior mediastinum accessible for study, the mediastinal pleura should now be separated from the mediastinum and turned laterally, as far back as the roots of the lungs. This separation of the pleura from the mediastinum can be very readily made above. Inferiorly the pleura is more firmly attached to the pericardium, but a complete separation of the two membranes is not so essential in this region.

The most anterior structure of the superior mediastinum is the thymus gland. This is an elongated bilobed structure, which lies behind the middle of the manubrium in relation posteriorly to the left innominate vein and the arch of the aorta. It varies considerably in its extent in different individuals, and is usually represented in the adult principally by a degenerated mass of adipose tissue. However, some small amount of true thymic tissue is generally present in it. After the position and extent of the thymus have been noted it should be removed.

It is advisable at this time to define the upper limit of the anterior extent of the pericardium. This is the line along which the parietal pericardium is reflected inward and down onto the pulmonary artery, aorta, and

When the pleural cavities have been thoroughly investigated, the mediastinum and its contents should be approached from the front. The subdivisions of the mediastinum are purely arbitrary and depend for their boundaries upon the extent of the serous pericardium. The serous pericardium, like each of the pleurae, is a single uninterrupted membrane which consists of visceral and parietal portions separated from each other by a narrow, fluid-filled space, the pericardial cavity. The visceral portion of the serous pericardium is closely applied to the external surface of the heart and is to be regarded as a part of that organ. From the surface of the heart the visceral pericardium is prolonged for a short distance along the external surfaces of the vessels which join the heart and is then reflected from them to become the parietal pericardium. The parietal pericardium, which forms the external wall of the pericardial cavity, will appear as a considerably thicker and tougher membrane than the parietal pleura, due to the association with it of the so-called fibrous pericardium. The fibrous pericardium is a layer of relatively dense fibrous tissue intimately blended with the external surface of the parietal serous pericardium, from which it cannot be separated as a definite membrane, and continuous through the fibrous sheaths of the vessels in the superior mediastinum with the deep fascia of the neck. No particular attention need be paid to it in the dissection.

The parietal pericardium is firmly attached inferiorly to the central portion of the diaphragm. On either side it is in relation to the right and left pleurae, from which it is separated only by a small amount of areolar tissue and the phrenic nerves. Anteriorly also it is overlapped by the two pleurae, except for the small bare area which has already been seen. Posteriorly it is loosely attached to the oesophagus and the descending aorta. The greatest superior extent of the pericardium is at the line of its reflection from the ascending aorta and the pulmonary artery. This is approximately at the level of a plane passing from the lower border of the manubrium sterni back to the lower border of the fourth thoracic vertebra, and consequently that plane has been chosen as the plane of separation of the superior from the inferior mediastinum.

The anterior mediastinum is the portion of the inferior mediastinum which lies anterior to the pericardium. Its full extent is now visible. Superiorly, where the right and left pleurae are in contact with each other, it has virtually no existence. More inferiorly it is as wide as is the bare area of the

to the left across the pulmonary artery and more abruptly downward to the right across the superior vena cava. (Fig. 24.)

The large vessels of the superior mediastinum should now be cleaned and studied. Most anteriorly will be found the innominate veins and the upper part of the superior vena cava. The right innominate vein (v. anonyma dextra) begins behind the right sternoclavicular articulation by the union of the right internal jugular and subclavian veins. From here it courses downward behind the right border of the manubrium, where it joins the left innominate at about the level of the lower border of the first costal cartilage. The left innominate vein is formed by the union of the left internal jugular and subclavian veins behind the left sternoclavicular articulation. From here it runs downward and to the right, behind the manubrium, from which it is partially separated by the thymus, to join the right innominate. In addition to the two large tributaries which form it, each innominate vein receives the internal mammary vein of its own side. The inferior thyroid veins, which descend from the neck in front of the trachea, usually join the left innominate vein, either singly or by a common trunk. The left superior intercostal vein should also be identified. This vessel drains the upper two or three left intercostal spaces, but this fact cannot be demonstrated at present. Its terminal portion will be found crossing the left side of the arch of the aorta to enter the inferior aspect of the left innominate vein.

The vena cava superior is formed by the union of the two innominate veins behind the lower border of the first right costal cartilage. From here it runs vertically downward to enter the right atrium of the heart. Its terminal portion is in the middle mediastinum, enclosed by the pericardium. Its upper portion is in the superior mediastinum and may now be seen. In addition to the innominate veins it receives the azygos vein. The arched terminal portion of this vessel will be found crossing above the root of the right lung to enter the posterior aspect of the vena cava superior.

The thoracic portion of the aorta is divided for descriptive purposes into three parts, each of which is in a different subdivision of the mediastinum. The first part, or ascending aorta, is in the middle mediastinum, enclosed by the pericardium. The second part, the arch of the aorta, is in the superior mediastinum and should now be studied. It begins behind the lower border of the manubrium sterni, slightly to the right of the midline, and takes an arched course upward, backward, to the left and downward, to become

superior vena cava, as the visceral pericardium of these vessels. In an obese subject this line of reflection is obscured by adipose tissue. It will be found helpful to make a short transverse incision through the anterior exposed part of the pericardium. The handle of the scalpel can then be introduced through this opening and passed upward in the pericardial cavity between

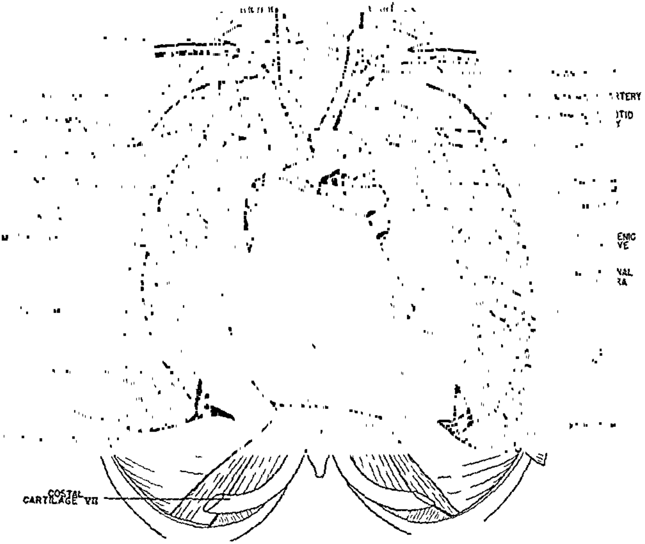

FIG. 24—Contents of the thoracic cavity The pleural sacs have been opened, and the mediastinal pleura stripped laterally on each side, to expose the pericardium and the structures of the superior mediastinum.

the anterior surface of the heart and the inner surface of the pericardium. The upward passage of the knife will be stopped at the line of reflection between visceral and parietal pericardium, which can then be cleaned from the outside. It will be found that the pericardium reaches its highest level just to the right of the midline, where it lies in front of the aorta. From the aorta the anterior line of pericardial reflection passes slightly downward and

cardiac plexus lies just under the arch of the aorta. It receives the superior cervical cardiac branch of the left sympathetic, and the inferior cervical and the thoracic branches of the left vagus. The remaining cardiac branches of the left vagus and sympathetic and all the cardiac branches of the right go to the deep cardiac plexus, which lies behind the arch, in front and at the sides of the terminal part of the trachea. From the cardiac plexuses small sympathetic nerve filaments pass along the vessels to form the pulmonary and coronary plexuses. The pulmonary plexuses constitute the nerve supply of the lungs. There is on each side an anterior and a posterior pulmonary plexus, which lie respectively anterior and posterior to the pulmonary artery at the root of the lung. From the pulmonary plexuses sympathetic nerves pass into the substance of the lung. The coronary plexuses supply the heart, branches of distribution accompanying the coronary arteries, which carry blood to the heart wall.

Under the arch of the aorta, and slightly to the left of it, the large pulmonary artery will be found emerging from the pericardium. Its extrapericardial course is very short; the pulmonary trunk terminates under the left side of the arch by dividing into right and left branches. The short left branch goes horizontally to the left to enter the root of the left lung. The longer right branch passes horizontally to the right under the arch of the aorta and then behind the superior vena cava and under the arch of the azygos vein to reach the root of the right lung. Connecting the under surface of the arch of the aorta with the upper and anterior aspect of the pulmonary trunk a thick cordlike structure will be found. This is the ligamentum arteriosum, the remnant in the adult of the ductus arteriosus of the fetus. In the adult it is solid, but during fetal life the ductus arteriosus is an open channel which permits blood to pass from the pulmonary trunk directly into the aorta. Crossing the under surface of the arch behind the ligamentum arteriosum the inferior laryngeal or recurrent branch of the left vagus will be found. This nerve leaves the vagus as the latter crosses the left side of the arch and turns medially and posteriorly beneath the arch to run upward through the superior mediastinum into the neck in relation to the trachea and oesophagus. Under the arch of the aorta it usually gives a few small twigs to the superficial cardiac plexus. Behind the pulmonary artery the left bronchus runs to the left and downward under the arch of the aorta, to enter the root of the left lung.

continuous at the left side of the fibro-cartilaginous disc between the fourth and fifth thoracic vertebrae with the descending aorta, which passes downward through the *posterior mediastinum* and will be exposed for study at a later stage of the dissection.

The beginning of the arch lies behind the *thymus*. Its highest part is covered anteriorly by the left innominate vein. Study of the aortic arch and its branches will be facilitated by sectioning the left *innominate vein* near its origin and reflecting it to the right. If this is done, the left superior intercostal vein should also be cut, where it enters the innominate, and retained in position.

To the left the arch of the aorta is in contact with the mediastinal pleura above the root of the left lung. Crossing the left side of the arch from above downward, and separating it from the pleura, will be found the left phrenic nerve and more posteriorly the left vagus If the dissection is carefully done two much smaller nerves may be found running downward across the arch between the phrenic and the vagus. These are the superior cervical cardiac branch of the left sympathetic trunk and the inferior cervical cardiac branch of the left vagus, both of which join the cardiac plexus.

The nerve supply of the heart and lungs is derived from the cardiac and pulmonary plexuses, which belong to the autonomic or sympathetic nervous system. *In the ordinary dissection, which must be done in considerable haste by an inexperienced dissector, it is neither practical nor essential to* attempt a complete display of these plexuses and their branches of origin and distribution. They are, however, of the greatest physiological importance, and it is well to have a general knowledge of their location, so that any portions of them which are met as the dissection proceeds may be recognized. The cardiac plexus is formed by branches from both sympathetic trunks and branches from both vagus nerves. The cervical portions of the sympathetic trunks usually each contribute three small branches to the plexus, which arise in the neck and enter the superior mediastinum through the superior thoracic aperture. Numerous small twigs are also given to the plexus from the thoracic portions of the sympathetic trunk. In addition to these nerves, two branches arise from each vagus in the neck and run down to join the plexus, while other branches leave the vagi in the upper part of the thorax. The cardiac plexus consists of two parts, superficial and deep, which are, however, intimately connected with each other. The superficial

cardiac plexus lies just under the arch of the aorta. It receives the superior cervical cardiac branch of the left sympathetic, and the inferior cervical and the thoracic branches of the left vagus. The remaining cardiac branches of the left vagus and sympathetic and all the cardiac branches of the right go to the deep cardiac plexus, which lies behind the arch, in front and at the sides of the terminal part of the trachea. From the cardiac plexuses small sympathetic nerve filaments pass along the vessels to form the pulmonary and coronary plexuses. The pulmonary plexuses constitute the nerve supply of the lungs. There is on each side an anterior and a posterior pulmonary plexus, which lie respectively anterior and posterior to the pulmonary artery at the root of the lung. From the pulmonary plexuses sympathetic nerves pass into the substance of the lung. The coronary plexuses supply the heart, branches of distribution accompanying the coronary arteries, which carry blood to the heart wall.

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Behind and to the right of the arch of the aorta are the trachea and the oesophagus, which can be more satisfactorily studied at a later stage of the dissection. Superiorly the principal structures in relation to the arch are its own three large branches, which should now be cleaned and examined.

The first is the innominate artery. This vessel arises behind the middle of the manubrium and passes upward, backward and to the right, to end at the level of the right sternoclavicular articulation by dividing into the right subclavian and the right common carotid arteries. It lies first anterior to and then to the right of the trachea. The terminal part of the left innominate vein lies to the right of it and slightly anterior throughout its course. The terminal part of the innominate artery is in contact posteriorly and to the right with the upper part of the right mediastinal pleura. The right vagus nerve will be found running downward and posteriorly between the artery and the right innominate vein. (Fig. 24.)

The second branch of the aortic arch is the left common carotid artery. It arises just to the left of the innominate artery and runs upward, to the left and backward, to enter the neck behind the left sternoclavicular articulation. In the superior mediastinum it is in relation to the trachea posteriorly and to the right, and to the left innominate vein anteriorly and to the left.

The left subclavian artery arises from the posterior part of the arch, and runs upward to the level of the left sternoclavicular articulation from which it arches to the left across the front of the dome of the left pleura. It lies behind the left common carotid artery and is in contact posteriorly and to the left with the left pleura throughout its course in the thorax. The left vagus nerve descends between the left subclavian and left common carotid arteries to reach the left side of the arch of the aorta, where it has already been seen.

A fourth much smaller branch is occasionally found arising from the arch of the aorta between the innominate and the left common carotid. This is the a. thyroidea ima or lowest thyroid artery, which runs up into the neck in front of the trachea. Rarely it may arise from the lowest part of the innominate artery instead of the aortic arch. In about 90% of cases it is entirely lacking.

The entire thoracic course of the two phrenic nerves may now be studied. Each phrenic nerve enters the thorax through the superior thoracic aperture by crossing the medial border of the scalenus anterior muscle. As it leaves the scalenus anterior it lies anterior to the subclavian artery and imme-

diately comes into relation with the internal mammary artery, the origin of which it may cross either anteriorly or posteriorly. The right phrenic nerve then runs down along the lateral side of the right innominate vein, then the lateral side of the superior vena cava, and finally along the right lateral surface of the pericardium, to reach the diaphragm. The left phrenic descends between the left subclavian and left common carotid arteries, crossing in front of the left vagus nerve, then across the left side of the arch of the aorta, in front of the root of the left lung, and finally along the left lateral surface of the pericardium to reach the diaphragm. It has already been seen that each nerve lies immediately subjacent to the mediastinal pleura throughout its course in the thorax. Small pericardiaco-phrenic blood vessels will be found accompanying the nerves. The arteries are branches of the internal mammary arteries; the veins drain either into the internal mammary veins or into the innominates.

The deeper structures of the superior mediastinum will be examined at a later stage of the dissection. Attention should be directed now to the middle mediastinum. Make a transverse incision clear across the middle of the exposed anterior surface of the pericardium. From each end of this transverse incision, longitudinal incisions must be carried downward to the diaphragm and upward almost to the upper limit of the pericardium. The two flaps so marked out may then be turned downward and upward respectively, thus opening the pericardial cavity and exposing the anterior surface of the heart. (Fig. 25.)

The pericardial cavity will appear as a narrow interval between the external surface of the heart and the internal surface of the parietal pericardium. In the dissecting room subject this cavity is sometimes partially obliterated by pathological adhesions between the heart and the parietal pericardium, or it may be filled with a coagulation of fluid present before death, or with an effusion of the substance used to inject the arteries after death. If any such material is present it should be removed. Anteriorly, inferiorly, and at each side, the heart normally lies quite free in the pericardial cavity, and there is no connection here between the parietal pericardium and the visceral pericardium which forms the thin outermost layer of the heart wall. Superiorly and posteriorly the heart is attached to the wall of the pericardial cavity by the great vessels which enter or leave it, and it is along the roots of these vessels that the parietal pericardium is reflected

to become continuous with the visceral pericardium. The upper and posterior part of the heart to which the vessels are attached is known as the base of the heart. The vessels joining the base of the heart should now be identified.

Most anteriorly is the pulmonary artery, which joins the upper left portion of the anterior surface of the heart. To the right of the pulmonary artery and somewhat overlapped by it is the aorta. Still farther to the right and more posteriorly is the intra-pericardial portion of the vena cava superior. The vena cava inferior will be found piercing the diaphragm to enter the lower posterior part of the heart at the right side. On each side two pulmonary veins enter the upper posterior part of the heart. Within the pericardial cavity these vessels are all covered by prolongations of the serous pericardium.

In connection with the pericardial reflections two small subdivisions of the pericardial cavity should be noted. These are the transverse sinus and the oblique sinus. The transverse sinus of the pericardium is a tunnel-like passageway lying behind the ascending aorta and the pulmonary artery, and connecting at each side with the general pericardial cavity. If the finger or a blunt instrument is introduced behind the pulmonary artery from the left side, and pushed transversely to the right, it will traverse the transverse sinus and emerge behind the right side of the ascending aorta and in front of the vena cava superior.

The oblique sinus is a pocket-like subdivision of the pericardial cavity which lies behind the base of the heart. It can be reached by pulling the lower free portion of the heart forward, upward, and to the right. Inferiorly and to the left the oblique sinus communicates freely with the general pericardial cavity. Its posterior wall is formed by the parietal pericardium which lies in front of the oesophagus and the descending aorta. Its anterior wall is formed by the visceral pericardium on the posterior surface of the left atrium. Its right border is formed by the reflection from the parietal to visceral pericardium across the left side of the right pulmonary veins and the vena cava inferior, its left border by a similar line of pericardial reflection across the right side of the left pulmonary veins, and its superior border is the line of junction of the visceral and parietal pericardium along the upper posterior border of the left atrium.

Although eight large vessels traverse the pericardial cavity to reach the heart, there are only two lines of pericardial reflection. This results from the

embryonic development of the heart as a simple tube connected to the wall of the pericardial cavity at the two ends, the venous end, through which blood enters the tube, and the arterial end, through which blood leaves it. The venous portion of the tubular embryonic heart is represented in the adult by the two atria and the veins which join them; the arterial portion is represented by the two ventricles and the arteries which leave them, and each of the lines of pericardial reflection of the adult marks the position of one of the two ends of the embryonic heart tube. These lines of pericardial reflection should now be studied. (Fig. 26.)

The arterial reflection can be easily seen at the upper anterior part of the pericardial cavity, where the aorta and the pulmonary artery are ensheathed in a common pericardial covering which is reflected from their external surfaces to become continuous with the parietal pericardium along a line encircling the vessels. The other line of reflection is more complex and encircles all six of the veins which enter the heart. Starting at the right side of the vena cava superior, where that vessel enters the pericardial cavity, the line along which the visceral and parietal pericardium are continuous runs downward along the right side of the right pulmonary veins and the vena cava inferior, across in front of the latter and up along its left side and the left side of the right pulmonary veins, then across the posterior aspect of the upper part of the left atrium, down on the right side of the left pulmonary veins, upward again along their left side, then to the right along the posterior wall of the transverse sinus, and finally across the front of the vena cava superior to reach the starting point. It should be noticed that the transverse sinus lies between the two pericardial reflections and marks the site of the obliterated dorsal mesocardium or dorsal mesentery of the embryonic heart. The oblique sinus is bounded entirely by the venous reflection.

Attention should now be directed to the anterior or sternocostal surface of the heart. This surface is formed principally by the right ventricle, but all four chambers of the heart contribute to it. Its right margin is formed by the right atrium, the auricle of which will be seen as a pointed appendage projecting upward and farther to the left than does the main part of the atrium. The right atrium is separated from the right ventricle by the coronary sulcus, which crosses the anterior surface of the heart, running downward and slightly to the right.

to become continuous with the visceral pericardium. The upper and posterior part of the heart to which the vessels are attached is known as the base of the heart. The vessels joining the base of the heart should now be identified.

Most anteriorly is the pulmonary artery, which joins the upper left portion of the anterior surface of the heart. To the right of the pulmonary artery and somewhat overlapped by it is the aorta. Still farther to the right and more posteriorly is the intra-pericardial portion of the vena cava superior. The vena cava inferior will be found piercing the diaphragm to enter the lower posterior part of the heart at the right side. On each side two pulmonary veins enter the upper posterior part of the heart. Within the pericardial cavity these vessels are all covered by prolongations of the serous pericardium.

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The oblique sinus is a pocket-like subdivision of the pericardial cavity which lies behind the base of the heart. It can be reached by pulling the lower free portion of the heart forward, upward, and to the right. Inferiorly and to the left the oblique sinus communicates freely with the general pericardial cavity. Its posterior wall is formed by the parietal pericardium which lies in front of the oesophagus and the descending aorta. Its anterior wall is formed by the visceral pericardium on the posterior surface of the left atrium. Its right border is formed by the reflection from the parietal to visceral pericardium across the left side of the right pulmonary veins and the vena cava inferior, its left border by a similar line of pericardial reflection across the right side of the left pulmonary veins, and its superior border is the line of junction of the visceral and parietal pericardium along the upper posterior border of the left atrium.

Although eight large vessels traverse the pericardial cavity to reach the heart, there are only two lines of pericardial reflection. This results from the

The relation of the anterior surface of the heart to the anterior thoracic wall is of importance and can be studied by replacing the portion of the sternum and its attached costal cartilages previously removed. The exact outline of the heart as projected against the chest wall varies somewhat in individual cases, but on the average is about as follows. Beginning at a point corresponding to the lower border of the second left costal cartilage about half an inch to the left of the edge of the sternum the left border follows a line somewhat convex to the left running down to the fifth intercostal space about three and a half inches from the midline. From here the inferior border follows a nearly straight line across to the sixth right costal cartilage about half an inch from the junction of this cartilage with the sternum. From here the right margin, somewhat convex to the right, runs upward to the upper border of the third right costal cartilage about half an inch from the sternum. The upper border, which corresponds to the junction of the vena cava superior with the right atrium and the junction of the right ventricle with the pulmonary artery, lies behind a line running from the upper border of the third right cartilage about half an inch to the right of the sternum to the lower border of the second left cartilage about half an inch to the left of the sternum.

The heart may be moved about in the pericardial cavity for observation of its other surfaces. The right lateral surface is formed entirely by the right atrium, and is in relation through the parietal pericardium with the right phrenic nerve and the right mediastinal pleura. The inferior or diaphragmatic surface is separated from the sternocostal surface by the sharp inferior border or margo acutus. This surface rests against the diaphragm, from which it is separated only by the diaphragmatic portion of the parietal pericardium. It is crossed by the inferior or posterior longitudinal sulcus, which meets the anterior longitudinal sulcus at the margo acutus. This sulcus separates the right ventricle from the left ventricle, each of which forms about half of the diaphragmatic surface.

The coronary sulcus completely encircles the heart, separating the two atria from the two ventricles. It has already been seen on the anterior surface of the heart. From here it should be followed around the lower right margin of the heart and back along the right edge of the diaphragmatic surface. From the diaphragmatic surface it runs upward around the upper left margin of the heart where it is overlapped by the left auricle, and then to

The sulci on the external surface of the heart are grooves or furrows in the muscular wall of the organ. In the undissected heart, however, they do not ordinarily appear as grooves since they are so completely filled with epicardial fat that the visceral pericardium covering them is not indented. Usually they may be readily recognized by the presence of this fat and by the fact that the coronary arteries and their larger branches are lodged in them. In cases, however, in which a fairly heavy layer of fat covers the entire outer

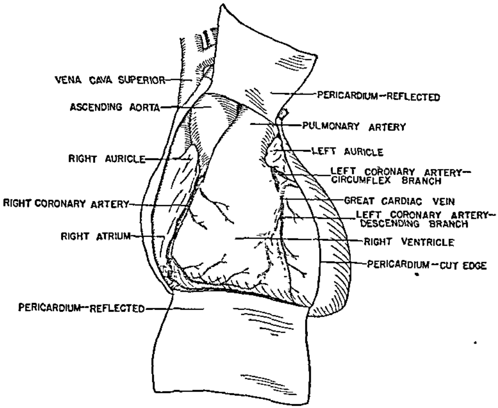

FIG. 25.—The sternocostal surface of the heart, exposed by reflection of the pericardium.

surface of the heart, and hides the coronary vessels, it may be impossible definitely to recognize the sulci without dissection.

The right ventricle forms about two-thirds of the sternocostal surface of the heart. It is widest below, just above the diaphragm. Superiorly it narrows and becomes continuous with the pulmonary artery. The left extremity of the anterior surface is formed by the left ventricle. This is separated from the right ventricle by the anterior longitudinal sulcus, which runs downward and to the left. At the left of the base of the pulmonary artery the auricle of the left atrium forms a small part of the sternocostal surface.

wall, can be seen. The myocardium of the posterior part of the wall of the right atrium, into which the veins open, is smooth. This portion of the atrium is known as the sinus venarum. It is marked off from the roughened anterior part by the crista terminalis. The latter will be seen as a longitudinal muscular ridge running from the vena cava inferior to the vena cava superior on the inner surface of the right wall of the atrium. Running forward from the crista terminalis on the inner surface of the atrial wall are smaller transverse muscular ridges, the musculi pectinati. These are particularly well developed in the auricle.

The vena cava superior opens into the highest part of the sinus venarum. Its opening has no valve. Below and posteriorly is the large opening of the vena cava inferior. Running across in front and to the left side of this opening is an endocardial fold, the valve of the vena cava inferior or Eustachian valve. To the left of the caval orifice is another opening in the lower posterior wall of the atrium, for the coronary sinus, a vein which is lodged in the posterior part of the coronary sulcus. This opening also is guarded by a rudimentary valvular fold. Anteriorly, inferiorly and toward the left the right atrium communicates with the right ventricle through the very large tricuspid or right atrioventricular orifice. The position of this opening corresponds to that of the lower and right portion of the coronary sulcus on the exterior of the heart. It lies behind the body of the sternum at about the level of the fourth intercostal space. It is guarded by the tricuspid valve, which can be studied to greater advantage when the right ventricle is opened. Other minute orifices may be seen scattered over the atrial wall. These are the openings of the venae cordis minimae, small veins which carry blood from the heart wall.

The postero-medial wall of the right atrium is formed by the atrial septum, which separates it from the left atrium. On this wall a shallow oval depression will be seen. This is the fossa ovalis and indicates the position of the foramen ovale, through which blood passed in the foetal heart from the right atrium directly into the left atrium. The fossa ovalis is bounded superiorly and anteriorly by a low semicircular ridge, the limbus fossae ovalis, which is usually continuous below with the valve of the vena cava inferior. In many cases a valvular passageway through the atrial septum persists in the adult, running from the upper part of the fossa ovalis behind the limbus, to open into the left atrium.

the right behind the pulmonary artery and the aorta in the transverse sinus of the pericardium, to reach the sternocostal surface. The anterior and posterior (or inferior) longitudinal sulci, which separate the two ventricles, begin at the coronary sulcus and meet near the left extremity of the margo acutus.

Instead of a distinct left surface, the heart presents at its left side the rounded margo obtusus, which is formed entirely by the left ventricle and is interposed between the sternocostal and diaphragmatic surfaces. The heart projects farthest to the left and inferiorly at its apex, which also is formed entirely by the left ventricle, and to which the margo acutus, the margo obtusus, the diaphragmatic surface, and the sternocostal surface all converge.

The *posterior surface corresponds to the base of the heart to which the* vessels are attached. Its only free portion is the surface of the left atrium which forms the anterior wall of the oblique sinus. The coronary sulcus runs between this surface and the diaphragmatic surface.

For the most part the interior of the heart can be studied to best advantage after the organ has been removed from the body. It is advisable, however, to open the right atrium while the heart is still in situ. Before doing this it will probably be necessary to open the pericardial cavity more widely on the right side than has previously been done. This can be accomplished by carrying a transverse incision backward through the right portion of the parietal pericardium. The right atrium should then be opened by three incisions. Make a longitudinal incision through the wall of the atrium beginning slightly below the tip of the auricle and running down to the inferior border of the atrium a little to the right of the coronary sulcus. From each end of this longitudinal incision carry a transverse incision backward to the posterior border of the atrium. The upper of these incisions will cross the atrium just below the termination of the vena cava superior and the lower just above the termination of the vena cava inferior. The flap thus marked out can then be turned to the right and backward and the interior of the atrium exposed. The cavity is usually filled with coagulated blood. This should be removed and the wall of the atrium cleaned as thoroughly as possible.

The inner surface of the right atrium, as of all the chambers of the heart, is lined with thin smooth epithelium, the endocardium, which is continuous with the endothelium of the blood vessels, and through which the muscular layer or myocardium, which forms the main thickness of the atrial

right side of the junction of the manubrium and body of the sternum it becomes continuous with the arch of the aorta. At its beginning it is overlapped anteriorly and to the left by the pulmonary artery, which should be separated from it, to expose the aortic sinuses. The aortic sinuses are three swellings or dilatations of the ascending aorta at its base. They correspond in position to the aortic semilunar valves, which lie within the ascending aorta and which will be seen somewhat later. The names used to describe the sinuses and the valves do not correspond to their actual position in the body. The terms used are right, left and posterior. It should be observed that the so-called right aortic sinus is actually anterior in position, the left sinus lies posteriorly and to the left, and the posterior sinus is posterior and to the right.

The only branches of the ascending aorta are the right and left coronary arteries. These are the arteries which supply the heart itself with blood and they should now be cleaned and studied. The coronary arteries and their larger branches are lodged in the fat which fills the sulci on the external surface of the heart. Cleaning them involves the removal of much of this fat. The cardiac veins, which carry blood back to the right atrium from the heart wall, will be met at the same time, and the larger of these should also be studied. Nerve filaments will be found in association with the vessels; these belong to the coronary plexus of nerves and represent branches of distribution of the cardiac plexus. They should be noted, but may be removed to facilitate cleaning of the vessels. (Figs. 25 and 26.)

The right coronary artery arises from the right aortic sinus behind the right border of the pulmonary artery. It runs downward and to the right in the coronary sulcus and then backward in the posterior part of the coronary sulcus where it terminates by anastomosing with the left coronary. At the upper end of the posterior longitudinal sulcus it gives a large posterior descending branch which runs in that sulcus. Throughout its course it gives branches which run downward over the wall of the ventricle and smaller branches which run upward in the wall of the right atrium. A large right marginal branch usually arises from it near the margo acutus. The right coronary artery carries blood mainly to the walls of the right atrium and right ventricle, and through its posterior descending branch, to the posterior half of the interventricular septum.

The left coronary artery arises from the left aortic sinus and passes to the left, behind the pulmonary artery in that portion of the coronary sulcus

When study of the right atrium is completed, the heart should be removed from the body. An excellent opportunity is now afforded for a review of the lines of pericardial reflection, since the heart is to be removed by cutting through the vessels along the lines of reflection of the pericardium. First cut through the ascending aorta and the pulmonary artery just below the level at which the pericardium is reflected from them. By pulling these cut vessels forward the transverse sinus can now be opened up and the continuity of the coronary sulcus along its lower border demon-

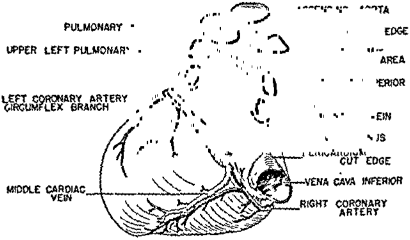

FIG. 26.—Posterior aspect of the heart, after removal from the body. The vessels have been cut along the lines of pericardial reflection.

strated. Next cut the vena cava superior transversely just below its entrance into the pericardial cavity, the vena cava inferior just above the diaphragm and the four pulmonary veins near their entrance into the heart. The visceral pericardium covering these veins will necessarily be cut at the same time as the vessels, and if the knife is also carried through the pericardium along the line of reflection connecting the veins, the heart will be freed from the pericardial wall and can be removed from the body. It should be observed that the only portion of the external surface of the heart which is devoid of a visceral pericardial covering is a narrow area running transversely across the upper posterior aspect of the organ between the upper right pulmonary vein and the upper left pulmonary vein. This area, which lies between the transverse sinus and the upper end of the oblique sinus, is formed by the upper border of the left atrium, and when the heart is in position it is in direct relation to the inferior surface of the right branch of the pulmonary artery. (Fig. 26.)

The ascending aorta takes origin from the left ventricle behind the left side of the sternum at the level of the third intercostal space. Behind the

half an inch to its right side. From the lower end of this incision carry another incision to the right, parallel to and just above the margo acutus, to within a quarter of an inch of the coronary sulcus. By this means the right ventricle and the pulmonary artery together will be widely opened. Any blood which fills them should be washed out.

The walls of the right ventricle are anterior, inferior and medial. The anterior wall corresponds to the sternocostal surface of the heart and the inferior wall to the diaphragmatic surface. The medial wall, which is

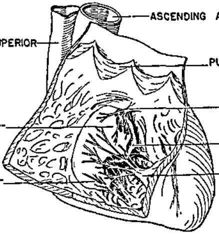

FIG. 27—The interior of the right ventricle of the heart.

actually posteromedial in position, is formed by the interventricular septum and separates the right ventricle from the left. This wall bulges forward and to the right, giving the cavity of the right ventricle a semilunar shape in transverse section. Almost the entire inner surface of the ventricle is thrown into irregular muscular ridges and bands, the trabeculae carneae. The cavity of the right ventricle narrows superiorly to become continuous with the pulmonary artery. The narrow superior portion of the right ventricle just below the pulmonary artery is known as the conus arteriosus. The conus, which is relatively free from trabeculae carneae, is marked off from the main ventricular cavity by a transverse muscular ridge on the septal wall of the ventricle, the supraventricular crest.

Posteriorly and to the right the ventricle communicates with the right atrium. The atrioventricular orifice is surrounded by a ring of fibrous tissue, the right annulus fibrosus. The muscle fibers in the wall of the atrium are not continuous through this ring with the muscle fibres of the ventricular wall, but this fact can not be very well demonstrated in the ordinary dissection. To the inner margin of the annulus fibrosus the tricuspid or right atrioventricular valve is attached.

which lies in the transverse sinus of the pericardium. As it emerges from the left end of the transverse sinus it is overlapped by the auricle of the left atrium and here divides into its two main branches, the anterior descending branch and the circumflex. The anterior descending branch runs downward and forward in the anterior longitudinal sulcus, giving numerous smaller branches to the sternocostal surface of the heart. The circumflex branch passes to the left and posteriorly in the coronary sulcus to anastomose with the terminal part of the right coronary. From it arise numerous branches to the left atrium and left ventricle and a left marginal branch of considerable size which follows the margo obtusus. The left coronary artery supplies most of the walls of the left atrium and left ventricle and the anterior half of the interventricular septum.

The cardiac veins return to the right atrium the blood carried to the heart wall by the coronary arteries. The largest of them is the coronary sinus, which is lodged in the posterior part of the coronary sulcus. It runs downward and to the right to terminate in the right atrium at the orifice which has already been seen in the interior of the atrium. The great cardiac vein runs upward in the anterior longitudinal sulcus and then around the left margin of the heart in the coronary sulcus to terminate in the coronary sinus, which may be regarded as its direct continuation. The middle cardiac vein ascends in the posterior longitudinal sulcus to join the coronary sinus near the termination of the latter; it is sometimes larger than the great cardiac vein. The small cardiac vein winds around the right margin of the heart in the coronary sulcus, to join the coronary sinus near its termination. The anterior cardiac veins are small veins which run upward on the right side of the anterior surface of the right ventricle. They may join the small cardiac vein or enter the right atrium directly. The oblique vein of the left atrium is a small channel which runs downward and to the right on the posterior surface of the left atrium to join the coronary sinus. It can not always be demonstrated. It is of interest because it represents a remnant of the left vena cava superior of the embryo.

When study of the blood vessels supplying the heart wall is completed the right ventricle should be opened. Make an incision beginning at the cut edge of the pulmonary artery and running downward through the anterior wall of the pulmonary artery and the right ventricle to the *margo acutus*; this incision should run parallel to the anterior longitudinal sulcus and about

half an inch to its right side. From the lower end of this incision carry another incision to the right, parallel to and just above the margo acutus, to within a quarter of an inch of the coronary sulcus. By this means the right ventricle and the pulmonary artery together will be widely opened. Any blood which fills them should be washed out.

The walls of the right ventricle are anterior, inferior and medial. The anterior wall corresponds to the sternocostal surface of the heart and the inferior wall to the diaphragmatic surface. The medial wall, which is

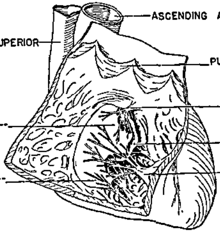

FIG. 27 —The interior of the right ventricle of the heart.

actually posteromedial in position, is formed by the interventricular septum and separates the right ventricle from the left. This wall bulges forward and to the right, giving the cavity of the right ventricle a semilunar shape in transverse section. Almost the entire inner surface of the ventricle is thrown into irregular muscular ridges and bands, the trabeculae carneae. The cavity of the right ventricle narrows superiorly to become continuous with the pulmonary artery. The narrow superior portion of the right ventricle just below the pulmonary artery is known as the conus arteriosus. The conus, which is relatively free from trabeculae carneae, is marked off from the main ventricular cavity by a transverse muscular ridge on the septal wall of the ventricle, the supraventricular crest.

Posteriorly and to the right the ventricle communicates with the right atrium. The atrioventricular orifice is surrounded by a ring of fibrous tissue, the right annulus fibrosus. The muscle fibers in the wall of the atrium are not continuous through this ring with the muscle fibres of the ventricular wall, but this fact can not be very well demonstrated in the ordinary dissection. To the inner margin of the annulus fibrosus the tricuspid or right atrioventricular valve is attached.

The tricuspid valve is an annular sheet of fibrous tissue, covered on each of its surfaces by a layer of endocardium; it is attached peripherally to the annulus fibrosus, and has a free margin projecting into the cavity of the ventricle. It is incompletely divided into three flaps or cusps by three notches in the free margin. The position of the cusps is usually as follows. The anterior cusp is in relation to the anterior sternocostal wall of the ventricle; the posterior cusp is in relation to the diaphragmatic wall; the medial or septal cusp is in relation to the medial wall. It should be observed that all three cusps are continuous with one another toward the annulus fibrosus and show a separation only near the free margin. Occasionally four cusps may be present.

Small fibrous strands will be seen running from the wall of the ventricle to attach to the free margin and to the ventricular surface of the tricuspid valve. These are the chordae tendineae, which serve to keep the cusps of the tricuspid valve from being forced back into the atrium when the ventricle contracts. Their attachment to the ventricular wall is at the papillary muscles. The papillary muscles are conical projections of the ventricular myocardium. The position of the papillary muscles of the right ventricle is not entirely constant. There is usually one large anterior papillary projecting into the ventricle from the anterior wall. From it chordae tendineae run to the adjacent margins of the anterior and the posterior cusps of the valve. There is usually a single small papillary muscle on the posterior wall of the conus arteriosus just to the left of the supraventricular crest. This is known as the papillary of the conus and gives chordae tendineae to the anterior and the septal cusps. Sometimes a large posterior papillary muscle is found projecting from the diaphragmatic wall, but more frequently this is represented by a group of smaller posterior papillaries, from which chordae tendineae run to the septal and the posterior cusps of the valve. The tricuspid valve serves to prevent the back-flow of blood from the ventricle into the right atrium. Where blood enters the ventricle from the atrium the valve is forced against the ventricular wall, leaving a wide opening. If, however, blood attempts to flow back through this opening the pressure forces the free edges of the three cusps together into the lumen of the ventricle closing the atrioventricular orifice.

The orifice which leads from the conus arteriosus of the right ventricle into the pulmonary artery lies behind the edge of the sternum at about the

level of the upper border of the third costal cartilage. It is guarded by the pulmonary semilunar valves, which should now be examined. These three valves are described as the anterior, the right and the left pulmonary semilunar valves, and together they completely surround the pulmonary orifice internally. It should be observed that the so-called anterior valve actually lies anteriorly and to the left, the right valve anteriorly and to the right, while the left valve is posterior in position. The anterior valve will probably have been injured when the ventricle was opened, but the structure of all three is similar. Each consists of a semilunar fold of fibrous tissue covered on both surfaces by an endothelial layer. One margin of each is attached to the wall of the pulmonary artery along a line convex toward the cavity of the ventricle. The other margin is free and projects into the lumen of the artery. When blood flows from the ventricle into the artery the valves are forced against the walls of the vessel. If blood attempts to flow from the artery into the ventricle, the valves bulge into the lumen and the three free margins meet, closing the orifice. At the middle of each free margin is a small fibrocartilaginous body, the nodulus. When the valve is closed the three noduli meet at the center of the lumen.

The left atrium may next be opened. This should be done by two incisions in the posterior wall of the atrium. The first should run from side to side across the posterior wall parallel to and just above the coronary sulcus. The other incision should be carried upward from the middle of the first to the upper border of the atrium; it will cut the posterior wall of the atrium longitudinally about halfway between the right and the left pulmonary veins. If it seems desirable to open the atrium still more widely a third incision may be made transversely across the upper border of the atrium between the two upper pulmonary veins. The cavity of the atrium is usually filled by the starch mass used to inject the arteries. This should be removed and the wall of the atrium cleaned.

The wall of the left atrium is smooth throughout, except in the auricle, where muscular ridges and strands are apparent. The auricle communicates with the main cavity of the atrium at its upper left side, just in front of the opening of the upper left pulmonary vein. The four pulmonary veins open directly into the atrium without valves. Below and to the left the atrium communicates with the left ventricle by the left atrioventricular or mitral orifice, which is somewhat smaller than the tricuspid orifice.

To the right and anteriorly the wall of the left atrium is formed by the atrial septum. At the anterior part of this wall a shallow semilunar depression will be seen, bounded posteriorly by a low ridge which corresponds in position to the fossa ovalis in the right atrium. An attempt should now be made to pass a blunt probe from the fossa ovalis of the right atrium forward and to the left through the atrial septum into the left atrium. In about 25% of cases a narrow passageway remains patent in this location in the adult, a remnant of the foramen ovale of the fetus. Such a passage is not necessarily attended by any symptoms of disease during life, since the pressure of the blood in the two atria keeps its walls in apposition.

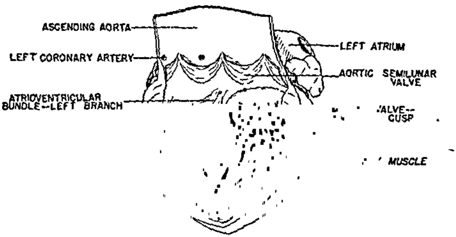

FIG. 28.—The interior of the left ventricle of the heart

The left ventricle is next to be studied. It and the ascending aorta can be opened together by a single incision. Enter the scalpel just below the coronary sulcus and carry it downward through the wall of the left ventricle along a line lying slightly to the left of the anterior longitudinal sulcus, to the apex of the heart. The same incision should then be continued upward from the point at which it was begun, through the coronary sulcus and the wall of the ascending aorta. This incision will cut the circumflex branch of the left coronary artery near its origin, where that vessel lies in the coronary sulcus; it will pass upward through the base of the ascending aorta just behind the origin of the left coronary artery, and then straight upward to the cut end of the aorta. The ascending aorta and the left ventricle may then be spread open, cleaned of blood and injection mass, and studied.

It will be observed that the wall of the left ventricle, except at the apex, is much thicker than is that of the right. The cavity of the ventricle is roughly conical in outline, the apex of the cone being represented by the apex

of the heart, and its base by the atrioventricular and aortic orifices together, the latter of which lies in front and slightly to the right of the former. The ventricular wall is covered throughout by trabeculae carneae, except in its upper anterior part, which leads to the aortic orifice and is known as the aortic vestibule. The anterior and right portion of the wall is formed by the interventricular septum, so that the left ventricle lies not only to the left of but also behind the right ventricle.

The left atrioventricular orifice lies behind the left side of the sternum at about the level of the fourth costal cartilage. Like the right orifice it is surrounded by a fibrous ring, the left annulus fibrosus, through which there is no continuity between the atrial and the ventricular musculature. The orifice is guarded by the mitral or bicuspid valve (valvula bicuspidalis), which is similar to the tricuspid valve in structure, with the difference that it ordinarily exhibits only two cusps. These cusps are anterior and posterior in position. Like the cusps of the tricuspid valve, they are prevented from being forced into the atrium by chordae tendineae, which run from the papillary muscles to the free margins and ventricular surfaces of the cusps. In most cases two very large papillary muscles will be found in the left ventricle. One of these springs from the lower part of the septal wall of the ventricle and the other from the diaphragmatic wall; from each of them chordae tendineae pass to both cusps of the valve. It should be noted that while a considerable portion of the right ventricular cavity intervenes between the tricuspid and pulmonary orifices, the only structure separating the mitral orifice from the aortic orifice is the anterior cusp of the mitral valve.

The aortic orifice lies behind the left side of the sternum at about the level of the third intercostal space. It leads from the upper anterior part of the left ventricle into the ascending aorta and is posterior to the conus arteriosus of the right ventricle. It is guarded by the three aortic semilunar valves. In details of structure these valves are similar to the pulmonary semilunar valves already examined, but it should be observed that they are much stronger. In position they correspond to the aortic sinuses, and are similarly named. The right valve will have been cut in opening the ventricle. Just above it on the inner wall of the aorta will be seen the orifice of the right coronary artery; above the left valve is the orifice of the left coronary artery. The posterior valve is in close relation to the anterior cusp of the mitral valve. (Fig. 28.)

Certain features of the interventricular septum deserve particular attention. It will be observed that the septum is for the most part thick and muscular. A small portion of it, however, is thin and membranous in character (pars membranacea septi ventriculorum). This is the upper posterior part of the septum and in the left ventricle lies just below and between the right and the posterior aortic semilunar valves. If the septum is held up to strong light the extreme thinness of this part of the septum can be easily demonstrated. It should be noted further that the membranous part of the septum is not entirely interventricular. Inferiorly it separates the left and right ventricles, but its highest part lies between the left ventricle and the right atrium, since the peripheral attachment of the septal cusp of the tricuspid valve crosses its right side.

It has been observed that the myocardium of the atria is not continuous with that of the ventricles, but is interrupted by the annuli fibrosi. Conduction of impulses from the atrial musculature to the ventricular musculature is accomplished by the atrioventricular bundle, a branched bundle of specialized cardiac muscle. The central point or node of this bundle lies just behind the membranous part of the interventricular septum, in the region where the left and the right annuli fibrosi meet. It receives strands of specialized muscle fibres from the walls of both atria, and gives a branch to each ventricle. The bundle as a whole can not be satisfactorily demonstrated in the ordinary dissecting room heart, but the left branch can frequently be seen without dissection, spreading downward over the septal wall of the left ventricle, immediately subjacent to the endocardium, through which it is often plainly visible. Individual strands from this branch, covered only by a layer of endocardium, sometimes bridge across the lower part of the cavity of the ventricle, to reach the posterior papillary muscle. They have been called the false chordae tendineae, since they resemble the chordae in appearance, though not in structure or function.

The next step in the dissection is the study of the trachea and the removal of the lower part of the trachea, the two lungs and the pleurae from the body. First strip the remains of the pericardium from the cut ends of the aorta, the pulmonary artery and the vena cava superior; it is well completely to remove all of the pericardium above the level of the upper pulmonary veins. The vena cava superior should then be turned laterally to the right, and the arch of the aorta turned laterally to the left. To do this

it will be necessary to cut the innominate artery slightly above its origin; the innominate may then be left in place against the trachea, and the arch of the aorta, with the left common carotid and left subclavian arteries still attached, swung over to the left side, thus exposing the lower part of the trachea and the right pulmonary artery. (See Fig. 29.)

The trachea divides into the right and left bronchi at about the level of the fifth thoracic vertebra, each bronchus then passing downward and

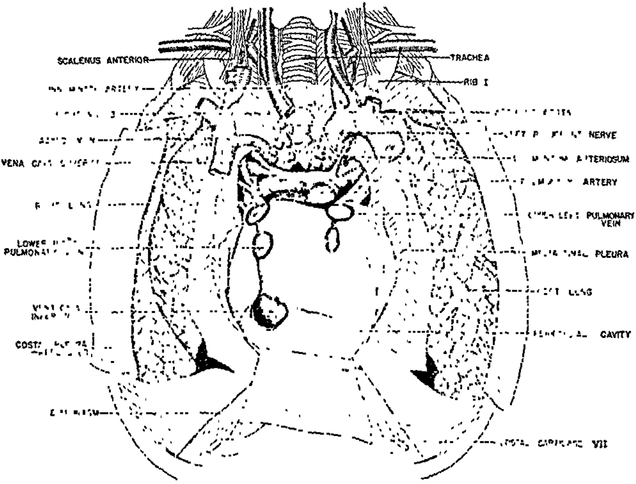

FIG. 29.—Dissection of the thoracic cavity, after removal of the heart. The arch of the aorta has been turned to the left, and the vena cava superior to the right.

laterally into the root of the corresponding lung. The pulmonary artery divides into right and left branches in front of the left bronchus. By replacing the aortic arch in position it can be demonstrated that the left bronchus and the right branch of the pulmonary artery lie under the arch. The deep cardiac plexus will be found in front of the lowest part of the trachea, between that structure and the right pulmonary artery. In cleaning the lower part of the trachea and the bronchi groups of large tracheal and bronchial lymph nodes will be met. These are usually blackened by the deposition in them of

carbon particles removed from the air in the lungs. When their position has been noted they should be removed. Observe that the left bronchus makes a sharper angle with the trachea than does the right. The right pulmonary artery may be cut through near its origin from the main trunk if the extra-pulmonary portions of the bronchi can not be satisfactorily cleaned while the pulmonary artery is intact.

The two lungs, together with the lower part of the trachea, the pulmonary artery and its branches, the pulmonary veins, and the remnants of the pleura are now to be removed together. First cut through the ligamentum arteriosum, which connects the pulmonary trunk to the under surface of the arch of the aorta. The recurrent branch of the left vagus turns upward behind this ligament on the inner surface of the aortic arch to reach the groove between the trachea and oesophagus; care should be taken not to injure it. Cut through the trachea, transversely, about two inches above its bifurcation. The oesophagus lies immediately behind the trachea, to which it is loosely attached by areolar tissue. Consequently some care is necessary to avoid cutting the oesophagus at the same time as the trachea. Pull the lower cut portion of the trachea forward and separate its posterior surface from the anterior surface of the oesophagus. Next free the cut ends of the pulmonary veins from the pericardium. This may be done either by stripping the pericardium from them or by cutting through each of the veins again just external to the pericardium. Next separate the parietal pleura completely from the thoracic wall wherever it may still be attached, by introducing the hand between the external surface of the pleura and the thoracic wall. In most cases it will strip off very readily except in the case of the diaphragmatic pleura. This may be left in place, the remainder of the parietal pleura being cut away from it with the knife. Nothing now holds the trachea, bronchi, lungs, pulmonary artery and veins, and pleurae in place except a little areolar tissue, and the whole complex of structures should be removed together from the body. In separating the left bronchus from the posterior part of the arch and the beginning of the descending aorta be careful not to injure the left vagus nerve, which runs downward behind the bronchus to come into relation with the oesophagus. Behind the right bronchus the right vagus and the azygos vein are apt to be injured if care is not taken.

The lungs may now be studied outside the body. The remains of the parietal pleura should be cut away along the lines of reflection between

visceral and parietal pleurae and discarded. The lungs of an ordinary dissecting room subject are not very favorable for study of their external form, and lungs from a body hardened with formalin, or good models made from such lungs should be studied if they are available. The surfaces of each lung are costal, mediastinal and diaphragmatic. A sharp inferior border (margo inferior) separates the diaphragmatic surface from the costal and mediastinal surfaces. Anteriorly the costal and mediastinal surfaces are separated from each other by a sharp anterior border (margo anterior). Posteriorly there is not so distinct a border separating the mediastinal from the costal surface. The portion of the costal surface which lies immediately posterior to the mediastinal surface is in relation not to the ribs but to the sides of the bodies of the vertebrae. The remainder of the costal surface is in relation to the ribs and intercostal spaces; it is very extensive and convex. The greatest posterior extent of the lung, as well as its greatest convexity is on this surface along a line corresponding to the angles of the successive ribs. The mediastinal surface is related through the mediastinal pleura with the various structures of the mediastinum, and the mediastinal surface of each lung shows characteristic grooves and ridges corresponding to the mediastinal structures with which it is in contact. The anterior margin of the left lung is cut by a wide cardiac notch (incisura cardiaca) corresponding to the protrusion of the apex of the heart to the left side. Each lung is marked anteriorly a little below its apex by a groove (sulcus subclavius) caused by the subclavian artery.

The lungs are divided into lobes by interlobar fissures. These fissures cut through the substance of the lung from the periphery nearly to the root. Unfortunately they are often difficult to demonstrate in the dissecting room, since adhesions between the opposing surfaces of the lobes, partially or wholly obliterating the fissures, are very frequent. The primary fissure of each lung lies in a oblique plane running downward and anteriorly from the posterior aspect a little below the apex, to the anterior part of the diaphragmatic surface. The left lung has only two lobes, upper and lower, separated by this fissure. In the right lung there is a second fissure running nearly horizontally backward and laterally from the anterior border at about the level of the fourth chondrosternal junction, to meet the main fissure. The right lung thus possesses upper, middle and lower lobes, the upper and middle lobes together corresponding to the upper lobe of the left lung.

The hilus of each lung is the region on its mediastinal aspect where the structures comprising the root of the lung enter it. The principal structures entering the hilus of each lung are the bronchus, the pulmonary artery and the pulmonary veins. The arrangement of these should be investigated now. Observe that as these structures approach the hilus in the root of the lung, the pulmonary veins are the most anterior in position and the bronchus is most posterior. The bronchi and the vessels should be followed into the lungs by dissecting away the lung substance sufficiently to demonstrate the following facts.

Each bronchus is continued downward and laterally to the base of the lung as the stem bronchus. From the stem bronchus arise a series of branches which are distributed to the various lobes. Near the hilus the pulmonary artery crosses the bronchus anteriorly to reach a position postero-lateral to the stem bronchus, which position it retains throughout the rest of its course. The first branch of the right bronchus is known as the eparterial bronchus since it arises above the point at which the right pulmonary artery crosses the bronchus. The eparterial bronchus is distributed to the upper lobe of the right lung and is accompanied by a branch of the right pulmonary artery and a tributary of the right superior pulmonary vein. The remaining branches of the right bronchus are known as hyparterial bronchi, since they arise below the crossing of the pulmonary artery. The larger ones runs anteriorly (ventrally) or posteriorly (dorsally) from the stem bronchus and the ventral and dorsal branches usually arise alternately. The first hyparterial bronchus is ventral and is distributed to the middle lobe; it is accompanied by a branch of the artery and a tributary of the upper right pulmonary vein. The remaining hyparterial branches are distributed to the lower lobe and are accompanied by branches of the artery and tributaries of the lower vein.

There is no eparterial bronchus in the left lung. The first hyparterial bronchus is quite large; it is distributed to the upper lobe and is accompanied by a branch of the left pulmonary artery and the upper left pulmonary vein. The remaining branches of the stem bronchus are distributed to the lower lobe, accompanied by branches of the artery and tributaries of the lower left vein.

An attempt should be made to identify the bronchial arteries. This is, however, often very difficult to do, since they are small and frequently

uninjected. The pulmonary artery carries venous blood to the lungs for aeration, after which it is returned to the heart by the pulmonary veins. The function of the bronchial arteries is to supply arterial blood to the lung substance itself. They should be looked for on the posterior aspect of the bronchi, the ramifications of which they follow in their distribution to the lungs. There are usually two bronchial arteries in the left lung and one in the right. The origin of the bronchial arteries will of course have been torn away in the removal of the lungs. The left ones arise from the upper part of the descending aorta; the right may arise from the descending aorta or from one of its upper right intercostal branches.

The posterior mediastinum and the deeper structures of the superior mediastinum should now be studied. Cut through the azygos vein at its termination in the vena cava superior and remove the remnants of the vena cava superior and the innominate veins. Remove any remnants of the parietal pleura which may remain adhering to the thoracic wall, with the exception that the diaphragmatic pleura may be left on the diaphragm. All of the pericardium except its diaphragmatic portion should also be removed. The removal of the portion of the parietal pericardium which formed the posterior wall of the oblique sinus will expose the lower part of the oesophagus. The oesophagus should now be cleaned and studied. In cleaning the oesophagus expose but do not injure the oesophageal plexus; this is a plexus of nerves derived from the two vagi, which is in intimate relation to the external surface of the oesophagus. (Fig. 30.)

The oesophagus is flattened to present anterior and posterior surfaces. It enters the thorax through the superior thoracic aperture. In the superior mediastinum it lies behind the trachea and in front of the bodies of the vertebrae. It is the most anterior of the structures in the posterior mediastinum, lying immediately behind the pericardium. In the upper part of the posterior mediastinum the descending aorta lies to its left side and slightly posterior to it. More inferiorly the oesophagus inclines slightly forward and toward the left so that it comes to lie in front of the aorta; it leaves the thoracic cavity by passing through an aperture in the muscular part of the diaphragm at about the level of the tenth thoracic vertebra.

The course of the two vagi in the posterior mediastinum should now be traced. After descending behind the left bronchus the left vagus crosses in front of the descending aorta to reach the anterior surface of the oesopha-

gus where it breaks up to form the anterior part of the oesophageal plexus. The right vagus passes downward across the medial aspect of the arch of the azygos vein to reach the posterior surface of the oesophagus, where it breaks up to form the posterior part of the oesophageal plexus. The anterior and posterior parts of the plexus communicate freely with each other around the borders of the oesophagus. A short distance above the diaphragm the plexus

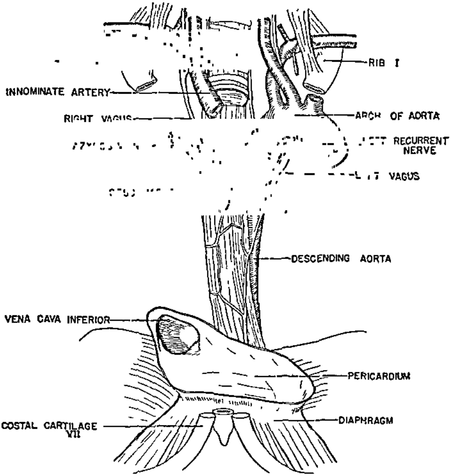

FIG. 30.—Semi-diagrammatic representation of the more anterior structures of the posterior mediastinum. The arch of the aorta has been turned to the left.

is usually resolved again into the main trunks of the two vagi. As they pass through the hiatus oesophagus of the diaphragm the left vagus lies on the anterior aspect of the oesophagus and the right vagus on its posterior aspect.

Cut through the oesophagus transversely at the same level at which the trachea was cut, and again just above its passage through the diaphragm and remove the intervening section of the oesophagus from the body. Observe that the lumen appears in section as a slit-like aperture, corresponding to the antero-posterior flattening of the organ. The areolar tissue of the posterior

mediastinum lying behind the oesophagus contains numerous important vessels yet to be investigated; consequently some care is necessary in separating the posterior surface of the oesophagus from this tissue.

Clean and study the descending aorta. It begins at the left side of the fibro-cartilage between the fourth and fifth thoracic vertebrae as a continuation of the arch of the aorta and lies entirely in the posterior mediastinum. In its descent through the posterior mediastinum it inclines slightly forward and to the right and leaves the thorax through the aortic orifice of the diaphragm (hiatus aorticus) which lies in the median plane in front of the first lumbar vertebra. The only branches arising from its anterior aspect are the bronchial arteries, of which mention has already been made, and a variable number of small oesophageal and mediastinal branches. These will have been removed with the oesophagus, but it may be possible to identify their cut ends. If the descending aorta is pulled forward a series of paired aortic intercostal branches will be seen arising from its posterior aspect. There are usually nine pairs of aortic intercostals, one for each pair of intercostal spaces beginning with the third.

The posterior intercostal arteries, the azygos system of veins, the proximal portions of the intercostal nerves and the thoracic portions of the sympathetic nerve trunks should now be studied together. Cut through the left common carotid and left subclavian arteries just above their origins, and the arch of the aorta at its junction with the descending aorta, and remove the arch. Then clean the sympathetic trunks. (Fig. 31.)

Each sympathetic trunk begins in the neck and is continued through the thorax into the abdomen and pelvis. It will be found passing through the superior thoracic aperture in front of the head of the first rib and running downward through the thorax in front of the heads of the ribs in the areolar tissue just external to the parietal pleura. In the lower part of the thorax it inclines slightly forward, coming to lie against the sides of the bodies of the vertebrae. It leaves the thorax by passing behind the diaphragm. A series of ganglionic enlargements occur along its course. These ganglia generally lie against the heads of the ribs; the first thoracic ganglion is sometimes fused with the lowest cervical ganglion to form a large stellate ganglion. Identify the greater splanchnic nerve. This large nerve arises from the sympathetic trunk by a series of roots, usually three but frequently more, which pass forward and downward along the sides of the vertebrae. The

gus where it breaks up to form the anterior part of the oesophageal plexus. The right vagus passes downward across the medial aspect of the arch of the azygos vein to reach the posterior surface of the oesophagus, where it breaks up to form the posterior part of the oesophageal plexus. The anterior and posterior parts of the plexus communicate freely with each other around the borders of the oesophagus. A short distance above the diaphragm the plexus

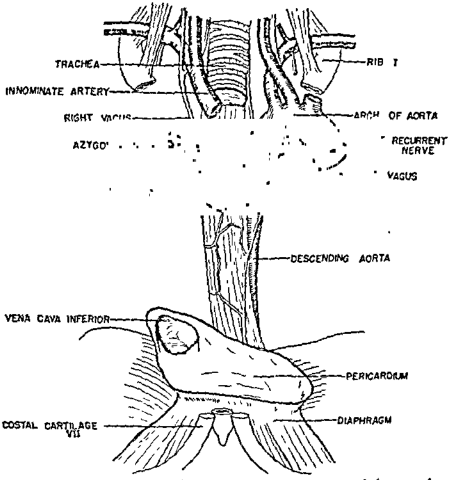

FIG. 30.—Semi-diagrammatic representation of the more anterior structures of the posterior mediastinum. The arch of the aorta has been turned to the left.

is usually resolved again into the main trunks of the two vagi. As they pass through the hiatus oesophagus of the diaphragm the left vagus lies on the anterior aspect of the oesophagus and the right vagus on its posterior aspect.

Cut through the oesophagus transversely at the same level at which the trachea was cut, and again just above its passage through the diaphragm and remove the intervening section of the oesophagus from the body. Observe that the lumen appears in section as a slit-like aperture, corresponding to the antero-posterior flattening of the organ. The areolar tissue of the posterior

spaces, where it will be observed that they lie on the internal surfaces of the external intercostal muscles, which extend as far medially as the heads of the ribs. It should be noted that the internal intercostal muscles extend medially only as far as the angles of the ribs and here the intercostal nerves pass out of sight by continuing laterally between the internal and external intercostal muscles. Their further course has already been followed in the dissection of the thoracic wall. Each intercostal nerve is accompanied by an intercostal vein and an intercostal artery throughout its course; the nerve is usually the most inferior in position and the vein the most superior of the three structures.

The posterior intercostal arteries of the first two intercostal spaces are usually derived from the costo-cervical branch of the subclavian. The superior intercostal branch of the costo-cervical trunk will be found descending in front of the neck of the first rib; it gives a branch to the first intercostal space and usually continues downward over the neck of the second rib to end as the intercostal artery of the second space. The posterior intercostal arteries of the lower spaces are branches of the descending aorta. Observe that the upper aortic intercostals run upward as well as laterally across the bodies of the vertebrae to reach the spaces they supply. As they cross the bodies of the vertebrae and the heads of the ribs the right aortic intercostals cross the posterior or external aspects of the thoracic duct, azygos vein, and right sympathetic trunk; the left aortic intercostals have a similar relation to the hemiazygos or accessory hemiazygos vein and the left sympathetic trunk.

The azygos system of veins and the thoracic duct can be studied to better advantage if the descending aorta is removed. Draw the aorta forward and cut through the entire series of aortic intercostals at their origin from the posterior aspect of the aorta; cut through the aorta transversely about half an inch above its passage through the diaphragm and remove it. Then clean the thoracic duct.

The thoracic duct, which drains all the lymph from the inferior extremities, pelvis, abdomen, thorax, left upper extremity, and left side of the head, is a small, very thin walled vessel, usually white or grey in color. It enters the thorax through the aortic orifice of the diaphragm, in which it lies behind and to the right of the aorta, and ascends in the midline through the posterior mediastinum, where it lies in the front of the bodies of the vertebrae

roots join to form the greater splanchnic nerve, which passes downward through the posterior muscular part of the diaphragm. The lesser splanchnic nerve runs forward and downward from the sympathetic trunk at a lower level; it also passes through the diaphragm, slightly posterior to the greater splanchnic nerve. Each of the thoracic ganglia usually communicates with

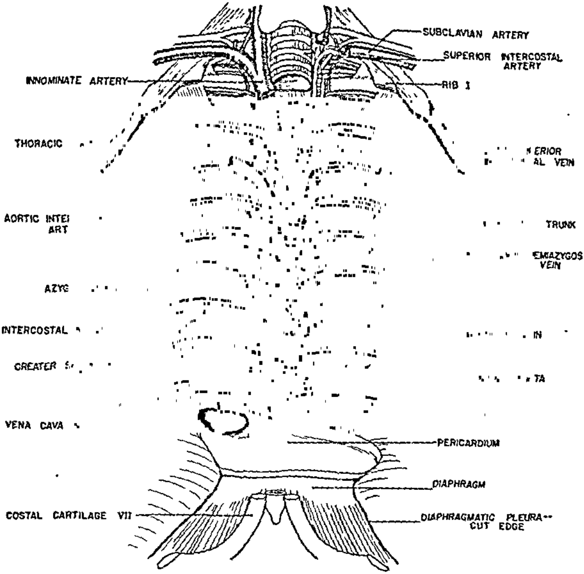

FIG. 31.—Dissection of the posterior thoracic wall, showing the deeper structures of the posterior mediastinum.

the corresponding intercostal nerve by two small posteriorly directed branches, the grey and white rami communicantes.

The intercostal nerves are the anterior rami of the first eleven pairs of thoracic spinal nerves; one will be found in each intercostal space emerging from the posterior aspect of the bodies of the vertebrae between the heads of the adjacent ribs. They should be followed laterally in the intercostal

the left superior intercostal vein, are drained by the accessory hemiazygos. This is a longitudinal channel in line with the hemiazygos but at a higher level. Superiorly it frequently communicates with the left superior intercostal vein; inferiorly it may join the hemiazygos or it may cross the vertebral column to join the azygos independently of the hemiazygos.

THE ABDOMINAL WALL

Before starting the dissection of the anterior abdominal wall, the surface landmarks should be observed. A glance at a skeleton will make it apparent that the bony wall of the abdominal cavity is much less complete than is that of the thoracic cavity. Superiorly, due to the dome-like shape of the diaphragm, the abdominal cavity is protected by the lower ribs, and inferiorly the coxal bone helps to form its wall, but in the region between, the only skeletal support of the abdominal wall is contributed by the lumbar vertebrae.

The costal arch, corresponding to the lower borders of the seventh to tenth costal cartilages on each side, can usually be seen and always felt from the surface. At the apex of the arch a depression is usually seen on the surface of the body, corresponding to the xiphoid process of the sternum. Below, on each side, the anterior superior iliac spine should be identified. Running backward and somewhat upward from the spine, the iliac crest can be readily palpated for some distance. In the mid-line below, the pubic symphysis can be felt, usually through a fairly heavy covering of fat; a little distance lateral to it on each side a sharp bony projection, the pubic tubercle, should be located. Stretching between the pubic tubercle and the anterior superior iliac spine, and separating the abdomen from the thigh, a curved linear depression is usually apparent. This corresponds to the line of the inguinal ligament; the ligament itself can usually be felt through the skin. Another linear depression stretches downward in the midline from the xiphoid process toward the pubis. This corresponds to the linea alba. On this line, nearer to the pubis than to the sternum, is the *umbilicus* or navel. In well developed subjects, three or four inches lateral to the linea alba, parallel to it above but turning medially below, another depressed line can be seen on each side. This indicates the position of the linea semilunaris, the lateral border of the rectus abdominis muscle.

When these points have been identified, the following incisions should be made through the skin. (1) In the midline, from the junction of the body

and right aortic intercostal arteries, and behind the oesophagus. In the superior mediastinum it bends to the left, emerging from behind the left side of the oesophagus to come into relation with the left pleura; it continues upward into the root of the neck, where it arches across the dome of the pleura to terminate in the origin of the left innominate vein or the termination of the left subclavian or left internal jugular vein.

The azygos system of veins consists of the azygos, hemiazygos, and accessory hemiazygos veins, the longitudinal channels into which most of the intercostal veins are drained. They should now be cleaned and studied. The azygos vein is a continuation of the right ascending lumbar vein of the abdomen; it enters the thorax through the hiatus aorticus, where it lies to the right of and behind the aorta and to the right of the thoracic duct. It ascends through the posterior mediastinum along the right side of the fronts of the bodies of the vertebrae to about the level of the fourth thoracic vertebra, where it arches forward over the root of the right lung to enter the vena cava superior. It receives all of the right intercostal veins except the first. The veins from the second, third and fourth spaces, however, usually do not enter the azygos directly, but unite to form a common trunk known as the right superior intercostal vein, which descends along the bodies of the upper vertebrae to reach the azygos. The intercostal vein of the first space usually drains into the innominate vein of its own side or into one of the tributaries of the innominate.

The drainage of the intercostal spaces of the left side is subject to a great deal of minor variation, and no precise description can be given to fit all cases. In the majority of cases, the left superior intercostal vein, the terminal part of which was seen at an earlier stage of the dissection crossing the left side of the arch of the aorta to terminate in the left innominate vein, receives the intercostal veins of the second, third and fourth spaces. The hemiazygos vein is a continuation of the left ascending lumbar vein; it enters the thorax by passing through the muscular substance of the diaphragm and will be found ascending in the posterior mediastinum in front of the left sides of the lower thoracic vertebrae and behind the left side of the aorta, to about the level of the eighth vertebra. Here it turns to the right behind the aorta and thoracic duct to enter the azygos; it receives the intercostal veins of the lower four or five spaces. The veins from the spaces between those drained by the hemiazygos and those drained by

ward over the scrotum, of which it forms the dartos layer, and posteriorly over the urogenital triangle of the perineum, where it is known as the fascia of Colles.

Scarpa's fascia and its attachment to the fascia lata of the thigh should now be demonstrated. Make a median vertical incision as far down as the pubic symphysis, through the superficial fascia on the lower part of the abdominal wall. The triangular flaps of fascia thus marked out should be reflected downward and laterally on each side toward the inguinal ligament. Scarpa's and Camper's fasciae should be reflected together as a single layer. Scarpa's fascia will then appear as a membranous stratum, usually reddish in color, on the deep surface of the reflected flap. The reflection can be continued only a very short distance beyond the inguinal ligament, because Scarpa's fascia here blends with the fascia lata. With removal of the fascia, the external oblique muscle and the rectus sheath will be completely exposed. At the same time the subcutaneous inguinal ring and a portion of the spermatic cord (round ligament in the female) will be uncovered. In series with the cutaneous nerves already exposed on the upper part of the abdominal wall, look for the terminal cutaneous portions of the iliohypogastric and the ilioinguinal nerves, which are derived from the first lumbar nerve. The former pierces the aponeurosis of the external oblique, often as two separate branches, a short distance above the inguinal ligament; the latter emerges through the subcutaneous inguinal ring with the spermatic cord.

Observe the linea alba. This is a dense aponeurotic cord, running from the xiphoid process to the pubic symphysis and intervening between the two recti muscles. The recti can not be seen at present, as each is hidden by the thick anterior layer of its aponeurotic sheath. The linea semilunaris is the line which marks the lateral border of the rectus muscle and the line along which the sheath becomes continuous with the aponeuroses of the three muscles which make up the lateral part of the anterior abdominal wall. The most superficial of these, the external oblique, should now be studied.

The external oblique muscle arises by eight fleshy slips from the outer surfaces of the lower eight ribs just lateral to their junctions with their costal cartilages. The upper slips are closely related to the serratus anterior and the lower to the latissimus dorsi. The fibres arising from the lower two or three ribs run downward to be inserted into the anterior third of the outer lip of the iliac crest. The remaining fibres are not inserted into bone, but run

with the xiphoid process of the sternum, downward to the pubic symphysis. This incision must encircle the edge of the umbilicus. (2) From the upper end of the first incision laterally and slightly downward across the body wall as far as the mid-axillary line. (3) From the lower end of the first incision laterally along the pubic crest to the pubic tubercle and then laterally and upward along the line of the inguinal ligament and for about two inches along the line of the iliac crest. The large quadrilateral flap of skin thus mapped out should now be reflected laterally on each side, to expose the superficial fascia of the abdominal wall.

On its external aspect the superficial fascia of the anterior abdominal wall does not differ appreciably from the same layer in other parts of the body, with the exception that in obese subjects it is extremely thick. Cut through its entire thickness in a straight line running transversely from one anterior superior iliac spine to the other. In making this incision be careful not to cut through the aponeurosis of the external oblique muscle or the sheath of the rectus muscle, which lie immediately subjacent to the superficial fascia; when these have been reached they may be recognized by their light, glistening appearance. All of the superficial fascia above this transverse incision should now be entirely removed, to expose the upper part of the rectus sheath and the external oblique muscle. As the fascia is being removed watch for the cutaneous nerves of the anterior abdominal wall. The anterior cutaneous nerves, which are the terminal portions of the lower intercostal nerves, pierce the rectus sheath in series from above downward, an inch or so lateral to the linea alba; running downward and forward over the lateral part of the external oblique muscle will be found the lateral cutaneous branches of the same nerves.

The superficial fascia on the lower part of the anterior abdominal wall, where it still remains in place, is peculiar in that it shows a differentiation into deep and superficial layers. The superficial layer, known as the fascia of Camper, is much the thicker; its exhibits the usual characteristics of the panniculus adiposus and is directly continuous below the line of the inguinal ligament with the superficial fascia of the thigh. The deeper layer, the fascia of Scarpa, which lies just external to the lower part of the aponeurosis of the external oblique muscle, is more membranous in character and ends immediately below the inguinal ligament by fusing with the deep fascia (fascia lata) of the thigh. Medial to the pubic tubercle it is continued down-

this canal the spermatic cord passes in its course from the interior of the abdominal cavity to the scrotum.

The subcutaneous inguinal ring is not an actual opening in the aponeurosis of the external oblique until it is made so by dissecting away the external spermatic fascia. This fascia is the outermost covering of the spermatic cord and may be regarded as an extension over the cord, downward into the scrotum, of the external oblique aponeurosis. It is a much thinner layer than the aponeurosis, with which it is continuous around the lips of the subcutaneous inguinal ring. (Fig. 32.)

The rectus abdominis muscle should now be studied, on the left side of the body. To open the left rectus sheath, make a longitudinal incision through its exposed anterior portion, parallel and just lateral to the linea alba from a point just below the xiphoid process of the sternum to a point just above the pubic symphysis. From each end of this incision carry a transverse incision laterally to the linea semilunaris. Observe that above the upper transverse incision the anterior part of the rectus sheath becomes much thinner and blends with the fascia of the pectoralis major muscle. The thin portion of the sheath above the upper transverse incision should be removed and the flap marked out by the three incisions turned laterally to expose the anterior surface of the rectus muscle.

First observe whether or not the pyramidalis muscle is present. This small, triangular muscle, which is totally lacking in about one fifth of cases, lies in front of the lower part of the rectus. It arises from the upper border of the body of the pubis and is inserted into the linea alba for a varying distance between the symphysis and umbilicus. Next study the rectus. The rectus abdominis is a broad flat muscle enclosed in an aponeurotic fascial sheath. It arises from the upper border of the body of the pubis and the anterior surface of the symphysis and is inserted upon the anterior surfaces of the fifth, sixth, and seventh costal cartilages and the xiphoid process of the sternum. Observe its tendinous inscriptions. These are irregular transverse tendinous bands, usually three in number, which cross the muscle, and are quite firmly attached to the anterior part of the sheath.

Detach the rectus from its insertion and turn the muscle forward and medially to expose the posterior layer of its sheath. This must be done with care, since there are other structures enclosed within the posterior part of the sheath that must be cleaned and studied as the muscle is being reflected.

downward and forward, to end in a broad sheet of fascia known as the aponeurosis of the external oblique. *Medial to the linea semilunaris* the aponeurosis of the external oblique is continued to the linea alba as one of the constituents of the *anterior layer of the fascial sheath of the rectus* abdominis muscle. Between the anterior superior spine of the ilium and

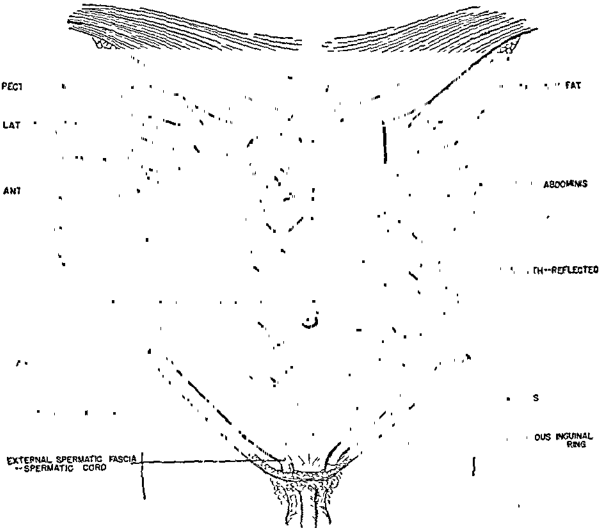

Fig. 32—Superficial dissection of the anterior abdominal wall. The rectus abdominis is exposed on the left side by reflection of the anterior layer of its sheath, and the external spermatic fascia has been dissected away, to reveal the borders of the subcutaneous inguinal ring.

the pubic tubercle the inferior border of the aponeurosis of the external oblique is thickened to form the inguinal ligament.

Define and observe the subcutaneous inguinal ring. This is an opening in the aponeurosis of the external oblique just above the medial end of the inguinal ligament; through it the spermatic cord (round ligament in the female) emerges from the inguinal canal. The inguinal canal is an oblique passageway through the lower part of the anterior abdominal wall; through

The external oblique muscle should now be reflected, to expose the internal oblique. Care is necessary here, since the layers of muscle in the anterolateral part of the abdominal wall are thin and separated from each other only by thin layers of fascia. Detach the upper four slips of origin of the external oblique from the fifth to eighth ribs. Then make a longitudinal incision through the muscle, running from the interval between its fourth and fifth slips of origin downward to the iliac crest. From the lower end of this incision carry a transverse incision through the muscle and its aponeurosis medially to the linea semilunaris. From the medial end of the transverse incision make a third incision running downward through the aponeurosis to reach the upper border of the subcutaneous inguinal ring. By these incisions the external oblique muscle and its aponeurosis will be cut into three portions. First reflect the large upper medial segment forward and medially to the linea semilunaris. Observe that at this line the external oblique aponeurosis joins the anterior layer of the rectus sheath. Then turn the smaller triangular lower medial segment downward and forward to the inguinal ligament. If the back has already been dissected the lateral segment should be detached from the lower four ribs and from the iliac crest and entirely removed. If the dissection of the back has not been done, this segment must be left in place. (Fig. 33.)

The reflection of the external oblique muscle and its aponeurosis will expose the internal oblique muscle and will also open up the medial portion of the inguinal canal. Clean and study the internal oblique. This muscle arises from the fused portion of the lumbodorsal fascia lateral to the sacrospinalis, from the intermediate lip of the anterior two thirds of the iliac crest, and from the lateral half of the inguinal ligament. The highest fibres are inserted upon the lower borders of the lower three or four ribs. The remaining fibres, as they approach the linea semilunaris, pass into an aponeurosis which joins the rectus sheath. Throughout most of its extent this aponeurosis splits into two parts, some fibres joining the anterior and some the posterior layer of the sheath; inferiorly, however, the entire aponeurosis of the internal oblique passes in front of the rectus.

The iliohypogastric nerve, whose terminal part was already seen piercing the external oblique, should now be traced back to the point at which it pierces the lower portion of the internal oblique.

These are the terminal parts of the lower intercostal nerves and the superior and inferior epigastric arteries. The lower five intercostal nerves pierce the posterior layer of the rectus sheath in longitudinal series near its lateral margin. They enter the deep surface of the rectus, which muscle they supply, and branches of them finally pierce the anterior layer of the sheath, where they have already been seen as the anterior cutaneous nerves of the abdominal wall.

The superior epigastric artery is one of the terminal branches of the internal mammary. It enters the rectus sheath by passing downward behind the seventh costal cartilage. It enters the deep surface of the muscle. The inferior epigastric artery is a branch of the external iliac artery. Its origin will be seen somewhat later in the dissection. It enters the lower lateral part of the rectus sheath and runs upward between the muscle and the posterior layer of the sheath, finally entering the muscle to anastomose with the superior epigastric. Occasionally a continuous inosculating channel may be found connecting the two epigastric arteries on the deep surface of the rectus. Both arteries are accompanied by veins.

Observe that the posterior layer of the rectus sheath is thicker and tougher above than below. In many cases a sharp inferior margin may be seen about half way between the umbilicus and the pubis, at which the posterior layer of the sheath appears to stop. This is the linea semicircularis. Below the linea semicircularis the rectus muscle rests posteriorly against the transversalis fascia, a thin fascial layer which lies just external to the peritoneum in the lower anterior abdominal wall. More frequently a distinct linea semicircularis is not discernible, the posterior layer of the sheath merely becoming gradually thinner in this region. The thinning of the posterior part of the sheath inferiorly is due to the fact that the fibres forming it (which are the medial continuations of the aponeuroses of the internal oblique and transversus muscles) pass in this region in front of the rectus to join the anterior layer of the sheath.

The further dissection of the anterior abdominal wall, for the display of the internal oblique and transversus muscles, should be done completely only on the left side. On the right side, the anterior abdominal wall should be retained undisturbed below a transverse line at the level of the anterior superior iliac spine, for subsequent study of the inguinal canal and its relation to inguinal hernia, from the interior of the abdominal cavity.

The external oblique muscle should now be reflected, to expose the internal oblique. Care is necessary here, since the layers of muscle in the anterolateral part of the abdominal wall are thin and separated from each other only by thin layers of fascia. Detach the upper four slips of origin of the external oblique from the fifth to eighth ribs. Then make a longitudinal incision through the muscle, running from the interval between its fourth and fifth slips of origin downward to the iliac crest. From the lower end of this incision carry a transverse incision through the muscle and its aponeurosis medially to the linea semilunaris. From the medial end of the transverse incision make a third incision running downward through the aponeurosis to reach the upper border of the subcutaneous inguinal ring. By these incisions the external oblique muscle and its aponeurosis will be cut into three portions. First reflect the large upper medial segment forward and medially to the linea semilunaris. Observe that at this line the external oblique aponeurosis joins the anterior layer of the rectus sheath. Then turn the smaller triangular lower medial segment downward and forward to the inguinal ligament. If the back has already been dissected the lateral segment should be detached from the lower four ribs and from the iliac crest and entirely removed. If the dissection of the back has not been done, this segment must be left in place. (Fig. 33.)

The reflection of the external oblique muscle and its aponeurosis will expose the internal oblique muscle and will also open up the medial portion of the inguinal canal. Clean and study the internal oblique. This muscle arises from the fused portion of the lumbodorsal fascia lateral to the sacrospinalis, from the intermediate lip of the anterior two thirds of the iliac crest, and from the lateral half of the inguinal ligament. The highest fibres are inserted upon the lower borders of the lower three or four ribs. The remaining fibres, as they approach the linea semilunaris, pass into an aponeurosis which joins the rectus sheath. Throughout most of its extent this aponeurosis splits into two parts, some fibres joining the anterior and some the posterior layer of the sheath; inferiorly, however, the entire aponeurosis of the internal oblique passes in front of ~~the rectus.~~

The iliohypogastric nerve, whose terminal part was already seen piercing the external oblique, should now be traced back to the point at which it pierces the lower portion of the internal oblique.

The inguinal canal has been partially opened by the reflection of the external oblique aponeurosis. This canal is an oblique passageway through the anterior abdominal wall; it lies just above the medial two-thirds of the inguinal ligament. Its anterior wall is formed throughout by the aponeurosis of the external oblique. Laterally, however, the lower fibres of the internal

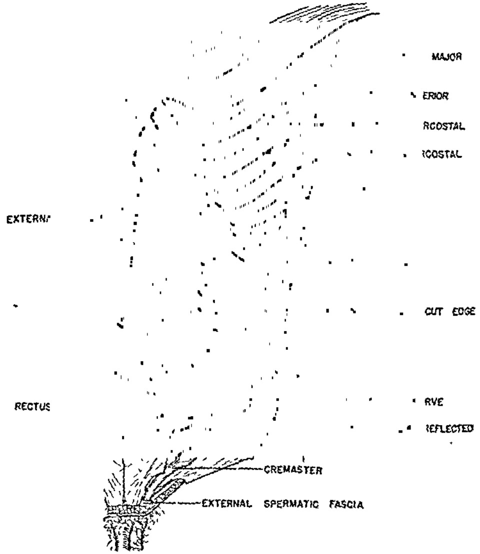

FIG. 33.—The left side of the anterior abdominal wall after reflection of the external oblique muscle.

oblique muscle aid the external oblique aponeurosis in forming the anterior wall of the inguinal canal. Consequently only the medial portion of the canal is at present ... ection. Observe that the spermatic cord, as it emerges into ... anal from behind the lower part of the internal obl... vering known as the cremasteric fascia and muscl...

The cremast ... bres which run down-... rd upon ... dissected it will be

found that some of these muscle fibres are prolonged along the cord as far as the testis, which they encircle. After the cord has emerged through the subcutaneous inguinal ring the cremaster layer is covered externally by the external spermatic fascia. The cremaster muscle may be regarded as a prolongation over the spermatic cord of the lowermost fibres of the internal oblique muscle.

Observe the lacunar ligament. This is a flat triangular ligament, which stretches across from the medial end of the inguinal ligament to the pecten of the pubis. For about half an inch of its course immediately internal to the subcutaneous inguinal ring the spermatic cord rests inferiorly upon the superior surface of the lacunar ligament. Consequently this ligament is said to form the floor of the most medial part of the inguinal canal. More laterally the floor of the inguinal canal is very narrow and is formed only by the inguinal ligament.

The internal oblique muscle should now be reflected. In cutting through the internal oblique be careful not to cut the lower intercostal nerves, which cross its deep surface, in the narrow interval between the internal oblique and transversus muscles. Make a longitudinal incision through the internal oblique in the same line as that of the longitudinal incision previously made in the external oblique. Medial to this incision the internal oblique should be detached above from any attachment it may have to the ribs, and below from its attachment to the iliac crest and the inguinal ligament. The broad flat medial portion of the muscle may then be reflected forward and medially, to the linea semilunaris. This will expose the external surface of the transversus abdominis muscle and the vessels and nerves which lie between the transversus and the internal oblique. (Fig. 34.)

The lower five intercostal and the subcostal (twelfth thoracic) nerves run downward and forward across the external surface of the transversus muscle, giving twigs of supply to the transversus and the internal and external oblique muscles. At the linea semilunaris they enter the rectus sheath, from which point their further distribution has already been seen. The iliohypogastric and ilioinguinal nerves, branches of the anterior ramus of the first lumbar nerve, have a similar course across the lower part of the transversus. They do not, however, enter the rectus sheath. The iliohypogastric has already been seen to pierce the internal oblique. The ilioinguinal nerve will be found crossing the transversus just above the lateral part of the inguinal

ligament, to enter the inguinal canal, through which it accompanies the spermatic cord to the subcutaneous inguinal ring.

Clean the exposed portion of the deep circumflex iliac artery. This vessel is a branch of the external iliac artery. Its origin will be seen later. At present it may be found piercing the transversus a short distance medial to the anterior superior iliac spine and running posteriorly along the iliac crest between the transversus and the internal oblique. Just in front of the

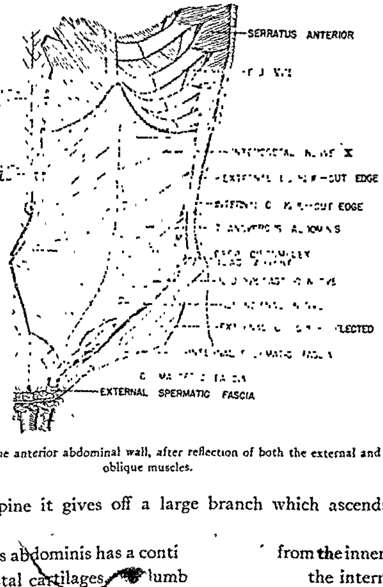

FIG. 34.—The left side of the anterior abdominal wall, after reflection of both the external and the internal oblique muscles.

anterior superior spine it gives off a large branch which ascends on the transversus.

The transversus abdominis has a conti from the inner surfaces of the lower six costal cartilages, lumb the internal lip of the iliac crest, and the lateral the ent. Its fibres cross the abdominal wall horizo d nea ilunaris in an aponeurosis which joins the rec Thr of its extent the aponeurosis of the transver pos the rectus sheath; inferiorly, however, it pas sheath.

Observe that the lowest portion of the aponeurosis does not reach the rectus sheath at all but passes downward, lateral to the narrow inferior portion of the sheath, to be attached directly to the pecten of the pubis. This portion of the aponeurosis of the transversus is known as the falx inguinalis. It is sometimes referred to as the conjoined tendon, from the fact that it also receives a few of the lowermost fibres of the internal oblique. Observe that the falx inguinalis lies immediately behind the portion of the spermatic cord that rests inferiorly upon the lacunar ligament. Consequently it is one of the constituents of the posterior wall of the inguinal canal.

Arching across from the lateral part of the inguinal ligament to the falx inguinalis the transversus muscle presents a free inferior border. Between this border and the inguinal ligament the transversalis fascia, the deepest layer of the anterior abdominal wall, is exposed. This layer forms the posterior wall of the inguinal canal throughout the length of the canal. Medially, however, the posterior wall of the inguinal canal is reenforced by the falx inguinalis, as has been seen.

By reflection of the external and internal oblique muscles, the entire anterior wall of the inguinal canal has been removed. The internal opening, or inlet, of the canal is thus exposed from the outside. This inlet, known as the abdominal inguinal ring, lies just above the middle of the inguinal ligament. It is described as an opening in the transversalis fascia, but as seen from the outside it does not appear so, since the transversalis fascia is prolonged outward along the spermatic cord to form the most internal of the cord's coverings, the internal spermatic fascia. (Fig. 34.)

Attention should next be directed, in the male body, to the penis and scrotum. Make a longitudinal incision through the skin of the penis running downward from the pubic symphysis to the tip. Then reflect the skin laterally to each side and remove it completely from the organ. Observe that the skin at the end of the penis forms a free fold, the prepuce, which covers the glans penis, the rounded extremity of the penis. The inner surface of the prepuce is covered with a layer of epithelium which is continuous around the margin of the glans with the epithelium covering the glans. The prepuce should be cut away from the margin of the glans penis as the skin is removed.

The root of the penis is situated in the perineum, firmly attached to the bone and fascia of that region. The free portion of the organ, now under

ligament, to enter the inguinal canal, through which it accompanies the spermatic cord to the subcutaneous inguinal ring.

Clean the exposed portion of the deep circumflex iliac artery. This vessel is a branch of the external iliac artery. Its origin will be seen later. At present it may be found piercing the transversus a short distance medial to the anterior superior iliac spine and running posteriorly along the iliac crest between the transversus and the internal oblique. Just in front of the

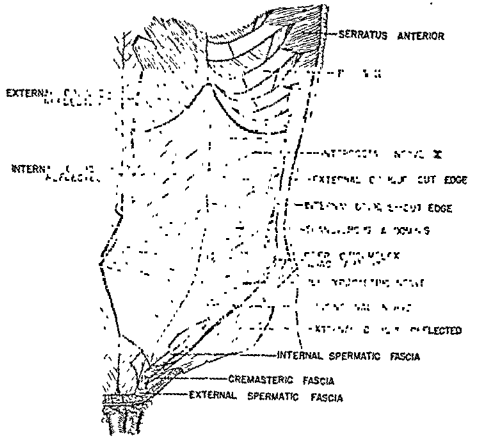

FIG. 34.—The left side of the anterior abdominal wall, after reflection of both the external and the internal oblique muscles

anterior superior spine it gives off a large branch which ascends on the transversus.

The transversus abdominis has a continuous origin from the inner surfaces of the lower six costal cartilages, the lumbodorsal fascia, the internal lip of the iliac crest, and the lateral third of the inguinal ligament. Its fibres cross the abdominal wall horizontally to end near the linea semilunaris in an aponeurosis which joins the rectus sheath. Throughout most of its extent the aponeurosis of the transversus joins the posterior layer of the rectus sheath; inferiorly, however, it passes into the anterior layer of the sheath.

The superficial fascia of the scrotum is known as the dartos tunic. It is continuous above with Scarpa's fascia. It is devoid of fat and usually dark red in color, due to the presence in it of smooth muscle fibres. In the midline it is prolonged backward to form a median septum which divides the scrotal sac into two parts. Reflect the dartos tunic from the anterior aspect of the left testis, and free the spermatic cord and testis, together with their coverings, entirely from the scrotum. Then study the spermatic cord between the subcutaneous inguinal ring and the testis.

The individual reflection of the three fascial coverings of the spermatic cord is extremely difficult of achievement in most cases, but should be attempted. These coverings are, from without inward, the external spermatic fascia, derived from the aponeurosis of the external oblique muscle, the cremasteric muscle and fascia, derived from the internal oblique, and the internal spermatic fascia, derived from the transversalis fascia. When they have been removed the various constituents of the spermatic cord proper will be exposed and should be identified.

The most important constituents of the spermatic cord are the ductus deferens, the internal spermatic artery, and the pampiniform plexus of veins. In addition are present the external spermatic nerve and artery, the small artery to the ductus deferens, and a sympathic nerve plexus for the supply of the testis.

The ductus deferens can always be recognized by its hard cord-like feeling. Through it the spermatozoa pass from the testis to the urethra. It is usually the most posterior of the structures in the spermatic cord. Its small artery may be seen on its external surface, if it happens to be well injected. The internal spermatic artery is the principal artery of supply for the testis. It is surrounded by the pampiniform plexus of veins, which return blood from the testis. The external spermatic nerve is a small nerve which supplies the cremaster muscle. It arises in the abdominal cavity as a branch of the genitofemoral branch of the lumbar plexus.

The tunica vaginalis of the testis is a serous membrane which forms a completely enclosed sac. It is invaginated by the testis and epididymis so that it presents visceral and parietal portions. The visceral tunica vaginalis is closely applied to the superior, inferior, anterior, medial, and lateral aspects of the testis and epididymis. Posteriorly the testis is not covered by the tunica vaginalis whose visceral portion is here reflected at either side to

observation, is suspended from the pubic symphysis. Define the suspensory ligament of the penis. This is a fibrous band which runs downward from the symphysis pubis to divide into two parts which are attached to the deep fascia on each side of the body of the penis.

Clean the vessels and nerves on the dorsum of the penis (anterior surface of the dependent organ). Most superficially, in the midline, is the superficial dorsal vein, which may be removed with the superficial fascia. In the deep fascia on the dorsum of the penis will be found the deep dorsal vein, and the dorsal arteries and nerves, all of which enter the present area of dissection by passing between the two parts of the suspensory ligament. The deep dorsal vein is in the midline. On either side of it are the dorsal arteries, and lateral to the artery on each side is the dorsal nerve. Numerous small branches arise from the artery and nerve as they approach the glans.

Attempt to separate by dissection the two main parts of which the body of the penis is composed. These are the corpus cavernosum penis and the corpus cavernosum urethrae. Observe that the glans penis is the expanded end of the corpus cavernosum urethrae. The third, or cavernous part of the urethra traverses the corpus cavernosum urethrae to terminate at the tip of the glans. It is best, however, not to open the urethra at present, but to wait until its three parts can be studied together. Section the corpus cavernosum penis transversely at about the middle of the body of the penis, and observe the character of the erectile tissue of which it is composed.

The scrotum is a sac of skin and fascia which contains the lower ends of the spermatic cords, and the *testes and their coverings. The coverings* of the testis are prolongations of the three fascial coverings of the spermatic cord, which are successively given to the cord, as has already been observed, in its passage through the inguinal canal. In addition to these, the testis has as its innermost covering, a serous layer, the tunica vaginalis, which was originally continuous with the peritoneal membrane of the abdominal cavity.

On the left side, make a longitudinal incision through the skin of the scrotum, from the region of the subcutaneous inguinal ring down to the lower end of the scrotum; then reflect the skin from the anterior aspect of the left side of the scrotum. Observe that this skin is thin and is rather firmly attached to the underlying superficial fascia.

border, where the vessels enter, this layer is thickened to form the mediastinum testis. From the mediastinum, fibrous partitions or septules radiate through the gland, dividing it into lobules. Within the lobules the seminiferous tubules are contained.

Make a transverse incision through the entire anterior abdominal wall, including the peritoneum, from a point a little above the anterior superior iliac spine on one side to the same point on the other side. Then draw the lower segment of the divided wall as far forward as possible, and observe the disposition of the peritoneum on the inner surface of the lower part of the abdominal wall. The peritoneum does not form a perfectly smooth internal covering for the abdominal wall, but projects backward into the abdominal cavity in the form of five ridges on the internal surface of the wall.

In the midline, running upward from the pubic symphysis to the umbilicus, is a ridge caused by the presence of the middle umbilical ligament, or urachus, which ascends from the apex of the bladder. Starting at the lower part of the anterior abdominal wall a short distance lateral to the midline on either side and running upward and medially to the umbilicus, is another peritoneal ridge caused by the presence of the lateral umbilical ligament, a fibrous cord which represents the obliterated portion of the foetal hypogastric artery. Still farther lateral is another peritoneal ridge caused by the inferior epigastric artery, which runs upward and medially in the lower part of the anterior abdominal wall, to enter the sheath of the rectus muscle. The latter ridge is often not very well marked. By means of these peritoneal ridges the peritoneum clothing the inner surface of the lower anterior wall is divided into three pairs of peritoneal fossae or pouches, which represent partial subdivisions of the general peritoneal cavity. Between the middle and the lateral umbilical ligaments on either side is the supra-vesical fossa; between the lateral ligament and the inferior epigastric artery is the medial inguinal fossa; lateral to the inferior epigastric artery is the lateral inguinal fossa. The relative width of the supra-vesical and medial inguinal fossae is subject to a good deal of variation and often differs on the two sides of the same body.

From the transverse incision already made in the anterior abdominal wall, carry a longitudinal incision down to the pubis. This incision should lie just to the left of the midline. Then approach the right inguinal canal from the interior of the abdominal cavity. (Fig. 35.)

become continuous with the parietal tunica vaginalis. Between the visceral and parietal portions is a narrow cavity filled by a small amount of serous fluid. Open this cavity by making a longitudinal incision through the anterior part of the parietal tunica vaginalis. This will expose the testis and epididymis, covered by the visceral tunica vaginalis. It should be observed, however, that diseased testes with complete or partial obliteration of the cavity of the tunica vaginalis, are fairly common in dissecting room subjects.

The testis is an oval body, somewhat flattened at the sides. It normally lies free in the cavity of the tunica vaginalis except posteriorly, where it is attached to the scrotal wall and to the epididymis. The epididymis is a curved, elongated structure applied to the posterolateral aspect of the testis. The lower end or tail of the epididymis (cauda epididymidis) is held to the lower end of the testis by the visceral tunica vaginalis. Its enlarged upper end or head (caput epididymidis) surmounts the upper end of the testis. The intervening portion or body (corpus epididymidis) is partially separated from the testis by an inpocketing of the lateral part of the cavity of the tunica vaginalis. This cleft-like portion of the cavity is known as the sinus of the epididymis.

Free the body and tail of the epididymis from the testis by cutting through the tunica vaginalis along each side of the epididymis. Observe that the ductus deferens begins at the tail of the epididymis, to run upward into the spermatic cord. Cut carefully through the visceral tunica vaginalis along its line of reflection from the upper end of the testis onto the head of the epididymis, to demonstrate the efferent ducts of the testis. These ducts (ductuli efferentes) are fifteen to twenty small ducts which carry the spermatozoa from the upper end of the testis into the head of the epididymis. In the epididymis these ducts eventually all unite to form a single duct, the ductus epididymidis. The body and tail of the epididymis consist of this single duct very greatly coiled upon itself. At the lower end of the tail it widens out to form the ductus deferens.

Observe that the arteries and veins of the testis enter and leave its posterior border, where it is not covered by the tunica vaginalis. Section the testis transversely at about its middle and attempt to see something of its structure in the cut surface. Immediately internal to the tunica vaginalis is a heavy fibrous layer, the tunica albuginea. Along the posterior

the inguinal ligament. The artery is lateral to the vein. Lateral to the artery, above and behind the inguinal ligament, is a layer of fascia known as the iliac fascia, which covers the psoas major and iliacus muscles. Running downward on the iliac fascia a short distance lateral to the external iliac artery, to reach the abdominal inguinal ring, will be found in the male the internal spermatic artery and vein and the external spermatic nerve.

Clean the inferior epigastric artery. Observe that it arises from the external iliac just before the latter passes behind the inguinal ligament, that it is crossed internally near its origin by the ductus deferens, and that it runs upward in the anterior abdominal wall, to pierce the transversalis fascia and enter the rectus sheath. In some cases another branch will be seen arising from the external iliac in common with the inferior epigastric, but turning medially to cross the external iliac vein and run to the pelvic brim. This is the obturator artery, which in the majority of cases arises within the pelvis as a branch of the hypogastric artery.

An inguinal hernia is the protrusion of a portion of the abdominal contents, usually a loop of intestine, into the inguinal canal. Two principal types of inguinal hernia may occur. An indirect, or oblique, inguinal hernia is one in which the loop of intestine enters at the abdominal ring, traverses the entire length of the inguinal canal, and emerges at the subcutaneous ring. A direct inguinal hernia is one which pushes through the posterior wall of the canal at some point medial to the abdominal ring, traverses the medial end of the canal, and emerges at the subcutaneous ring. Any inguinal hernia will push before it, as the most internal of its coverings, a layer of peritoneum, but its outer coverings will differ according to the point at which it enters the canal.

If the little finger is introduced into the abdominal ring from the interior of the abdominal cavity and pushed through the inguinal canal to the subcutaneous ring, the coverings of an indirect hernia may be readily demonstrated. It will be found that they are the same as the normal coverings of the spermatic cord. As the finger emerges through the subcutaneous ring it is covered externally by internal spermatic, cremasteric, and external spermatic fascia. If such a hernia reaches so far as the scrotum, it will appear there in the interval between internal spermatic fascia and parietal tunica vaginalis.

Carefully remove a roughly circular piece of peritoneum, about two inches in diameter, from the internal abdominal wall, with the abdominal inguinal ring as the center of the circle. The position of the abdominal inguinal ring can often be readily recognized while the peritoneum is still in place, from the fact that the peritoneum dimples into it for a short distance. If this is not the case, its approximate location can be determined by comparison with the left side, where the ring has already been exposed from the exterior. After removal of the piece of peritoneum, removal of the loose

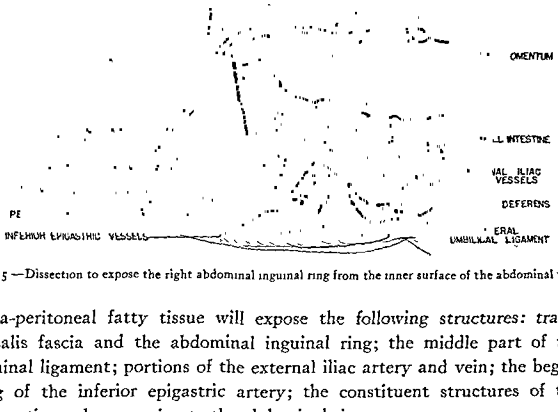

FIG. 35 —Dissection to expose the right abdominal inguinal ring from the inner surface of the abdominal wall.

extra-peritoneal fatty tissue will expose the *following structures: transversalis* fascia and the abdominal inguinal ring; the middle part of the inguinal ligament; portions of the external iliac artery and vein; the beginning of the inferior epigastric artery; the constituent structures of the *spermatic cord converging to the abdominal ring.*

The transversalis fascia stretches upward from the inguinal ligament. As seen from the inside, the abdominal inguinal ring appears as an opening in this fascia, just above the middle of the inguinal ligament. Observe that the ductus deferens enters the abdominal cavity at the abdominal inguinal ring. At the inguinal ligament it turns downward and medially and crosses in front of the external iliac vessels, to run toward the brim of the pelvis immediately external to the peritoneum. In the female its place is taken by the round ligament of the uterus.

The external iliac artery and vein are large vessels which run downward across the medial side of the present area of dissection, to disappear behind

female the peritoneum is pierced by two small openings, the mouths of the uterine tubes, but elsewhere completely encloses the peritoneal cavity. The peritoneum is an extremely complex membrane, from the fact that it is invaginated by numerous abdominal organs, whose outer, serous coat it forms. Before proceeding to a detailed study of the peritoneum, identify the various abdominal organs which project into the peritoneal cavity.

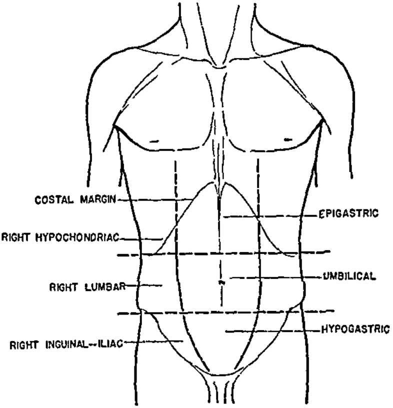

FIG. 36.—Diagram to illustrate the planes of subdivision of the abdominal cavity, as projected on the surface of the body

The liver is a large, solid, brownish red organ occupying the right hypochondriac and parts of the epigastric and left hypochondriac regions. The stomach is an expanded hollow organ continuous with the oesophagus just below the diaphragm; it is to be found in the epigastric and left hypochondriac regions, partially overlapped anteriorly by the liver. The appearance of the stomach varies greatly in different subjects. Its walls are often completely collapsed and contracted, so that its characteristic outline does not appear. Behind the upper part of the stomach and just below the diaphragm in the left hypochondriac region is the spleen, a solid organ similar in color to the liver. At its right extremity, behind the liver, the stomach narrows to become continuous with the duodenum, the first part of the small intestine. Only the beginning of the duodenum can now be seen, passing

Observe that the coverings of a direct inguinal hernia will not be in all cases the same. A direct hernia which enters the posterior wall of the canal just medial to the abdominal ring will push before it a covering of transversalis fascia, which will take the place of the internal spermatic fascia, and will appear in the scrotum in the interval between internal spermatic and cremasteric fascia. A direct hernia, however, which enters the inguinal canal by pushing through the medial end of its posterior wall, will receive neither internal spermatic fascia nor cremasteric fascia, but in place of them coverings derived from the transversalis fascia and the falx inguinalis respectively. As it passes through the subcutaneous ring it will lie internal to the external spermatic fascia, and will appear in the scrotum, with its covering of peritoneum, transversalis fascia, and falx inguinalis, in the interval between external spermatic and cremasteric fascia.

THE ABDOMINAL CAVITY

The abdominal cavity has already been partially opened by a transverse and a lower longitudinal incision. Completely open the cavity by making a second longitudinal incision through the entire thickness of the wall, running upward from the transverse incision to the costal arch, immediately to the left of the median line. By this means, the peritoneal cavity, which is contained within the abdominal cavity, will be widely opened from the front.

The abdominal cavity is arbitrarily divided for purposes of reference into nine regions, by two transverse and two longitudinal planes. The upper transverse plane passes transversely through the abdominal cavity at the level of the lowest portions of the tenth costal cartilages; the lower transverse plane is at the level of the anterior superior iliac spines. The longitudinal planes pass through the cavity on either side in the line of the linea semilunaris, the lateral border of the rectus abdominis muscle. The subdivisions of the cavity made by these planes are, above the upper horizontal plane, a right and left hypochondriac and a median epigastric region; between the two transverse planes, a right and left lumbar and an umbilical region; below the lower transverse plane, a right and left inguinal, or iliac, and a hypogastric region. (Fig. 36.)

The peritoneum is the great serous membrane of the abdominal cavity. In the male it forms a completely closed sac, the peritoneal cavity. In the

but it may turn upward behind the coecum or exhibit other variations in position. Running upward through the right iliac and lumbar regions, closely applied to the posterior wall, is the ascending colon. Under cover of the lower right border of the liver is the right colic flexure, at which the ascending colon becomes continuous with the transverse colon. At the left colic flexure, which is in the left hypochondriac region in relation to the lower part of the spleen, the transverse colon becomes continuous with the descending colon. The latter passes downward through the left lumbar region to become continuous in the left iliac region with the sigmoid or pelvic colon, which crosses the left side of the pelvic brim to enter the cavity of the pelvis minor.

Now make a study of the peritoneum as a whole. The peritoneum may be subdivided, from its relation to other structures, as visceral peritoneum, i.e., peritoneum forming the outer coat of a visceral organ; parietal peritoneum, i.e., peritoneum forming the walls of the peritoneal cavity; and the peritoneum of the various peritoneal ligaments or mesenteries. These ligaments are double folds of peritoneum which help to hold the viscera in place, and through which blood-vessesls and nerves reach the various intra-peritoneal organs. They may represent the continuity of visceral with parietal peritoneum or they may connect the visceral peritoneum of two or more organs. The parietal peritoneum is closely applied anteriorly and laterally to the inner surface of the abdominal wall, and superiorly to the inferior surface of the diaphragm. The posterior extent of the peritoneal cavity is not, however, so great as is that of the abdominal cavity, and numerous structures will be found at later stages of the dissection, which are within the abdominal cavity, but behind the posterior parietal peritoneum. Such structures are described as retro-peritoneal. Organs which project freely into the peritoneal cavity and receive a coat of visceral peritoneum are described as intra-peritoneal. Inferiorly the peritoneum descends below the pelvic brim, where its disposition will be observed when the pelvis is studied.

Observe the falciform ligament of the liver. This is a double fold of peritoneum, which connects the parietal peritoneum of the anterior abdominal wall with the visceral peritoneum clothing the anterior surface of the liver. Its attachment to the anterior surface of the liver marks the junction of the right and left lobes of that organ. Inferiorly it presents a free margin,

to the right behind the liver to disappear in the posterior wall of the peritoneal cavity. It is advisable to inflate the stomach with air, which may be pumped into the oesophagus through the mouth; or if the thorax has been dissected it may be introduced into the esophagus just above the diaphragm. The oesophagus should then be ligatured, to prevent escape of the air. It may be necessary also to ligature the first part of the duodenum, to prevent the air from passing into the small intestine.

When the stomach is inflated observe that its broad convex anterior surface (which is actually antero-superior in position) is covered by the liver above, but is in contact with the lower anterior part of the diaphragm and the anterior abdominal wall below. The curved right and upper border of this surface is known as the lesser curvature of the stomach; the much longer curved border formed by the left and inferior margin is known as the greater curvature.

Descending from the lower part of the greater curvature is the great omentum, a broad free fold of peritoneum containing a considerable quantity of fat. The extent of the great omentum below the greater curvature varies in different subjects; in some cases it extends well into the hypogastric region, completely covering anteriorly the coils of small intestine which fill the lower part of the peritoneal cavity. Turn the great omentum upward and observe that its upper posterior border is attached to the transverse colon, a portion of the large intestine which crosses the peritoneal cavity from right to left.

Turn the transverse colon upward, together with the peritoneal fold which attaches it to the posterior wall of the peritoneal cavity, and identify the duodenojejunal flexure. At this point, which is slightly to the left of the midline, in the upper part of the umbilical region, the duodenum emerges from the posterior peritoneal wall, to become continuous with the jejunum, the second part of the small intestine. The numerous coils of the jejunum and the ileum (the third part of the small intestine) fill the umbilical and hypogastric regions and also extend into the cavity of the pelvis minor. Draw them forward and observe that they attached to the posterior wall by a broad thick peritoneal fold, the mesentery.

In the right iliac region the ileum ends by joining the coecum, the first part of the large intestine. Identify the vermiform appendix. This finger-like process typically projects to the left from the lower end of the coecum,

but it may turn upward behind the coecum or exhibit other variations in position. Running upward through the right iliac and lumbar regions, closely applied to the posterior wall, is the ascending colon. Under cover of the lower right border of the liver is the right colic flexure, at which the ascending colon becomes continuous with the transverse colon. At the left colic flexure, which is in the left hypochondriac region in relation to the lower part of the spleen, the transverse colon becomes continuous with the descending colon. The latter passes downward through the left lumbar region to become continuous in the left iliac region with the sigmoid or pelvic colon, which crosses the left side of the pelvic brim to enter the cavity of the pelvis minor.

Now make a study of the peritoneum as a whole. The peritoneum may be subdivided, from its relation to other structures, as visceral peritoneum, i.e., peritoneum forming the outer coat of a visceral organ; parietal peritoneum, i.e., peritoneum forming the walls of the peritoneal cavity; and the peritoneum of the various peritoneal ligaments or mesenteries. These ligaments are double folds of peritoneum which help to hold the viscera in place, and through which blood-vessesls and nerves reach the various intra-peritoneal organs. They may represent the continuity of visceral with parietal peritoneum or they may connect the visceral peritoneum of two or more organs. The parietal peritoneum is closely applied anteriorly and laterally to the inner surface of the abdominal wall, and superiorly to the inferior surface of the diaphragm. The posterior extent of the peritoneal cavity is not, however, so great as is that of the abdominal cavity, and numerous structures will be found at later stages of the dissection, which are within the abdominal cavity, but behind the posterior parietal peritoneum. Such structures are described as retro-peritoneal. Organs which project freely into the peritoneal cavity and receive a coat of visceral peritoneum are described as intra-peritoneal. Inferiorly the peritoneum descends below the pelvic brim, where its disposition will be observed when the pelvis is studied.

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running downward and forward from the lower border of the liver toward the umbilicus. Within this free margin is contained the ligamentum teres of the liver, a cord-like structure representing the obliterated umbilical vein of the fetus.

Pass the hand upward over the right side of the liver and identify the coronary ligament. This is a broad peritoneal fold through which the peritoneum on the upper and posterior surfaces of the liver becomes continuous with the peritoneum on the under surface of the diaphragm. Its sharp right free margin is known as the *right triangular ligament.* To the left of the attachment of the falciform ligament, connecting the diaphragmatic peritoneum with the peritoneum on the upper surface of the left lobe of the liver, is the narrow left triangular ligament.

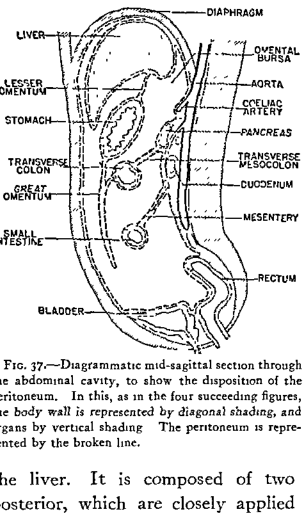

FIG. 37.—Diagrammatic mid-sagittal section through the abdominal cavity, to show the disposition of the peritoneum. In this, as in the four succeeding figures, *the body wall is represented by diagonal shading,* and organs by vertical shading The peritoneum is represented by the broken line.

Draw the left lobe of the liver forward and observe the lesser omentum. *This is a flat peritoneal ligament* which runs from the lesser curvature of the stomach and the upper border of the first part of the duodenum to the inferior surface of the liver. It is composed of two layers of peritoneum, anterior and posterior, which are closely applied to each other except near the right free margin, which runs from the duodenum to the lower part of the inferior surface of the liver. Around this margin the two layers are *continuous with each other.* Observe that near this right free margin the lesser omentum is thick; this is due to the presence within it of the hepatic artery, the portal vein, and the bile duct. At the lesser curvature the peritoneum comprising the lesser omentum becomes continuous with the visceral peritoneum clothing the anterior and posterior surfaces of the stomach. At the liver, whose inferior surface it reaches along the line

separating the right and left lobes, it becomes continuous with the visceral peritoneum on the inferior surface of the liver. (Figs. 37, 38, 39.)

The falciform ligament, the coronary and the right and left triangular ligaments of the liver, and the lesser omentum are all derived from the ventral mesentery of the embryonic gut. The representatives in the adult of the embryonic dorsal mesentery are the gastrophrenic, lienorenal, and lienogastric ligaments, the great omentum, the transverse mesocolon, the mesentery of the jejunum and ileum, and the sigmoid mesocolon. These should now be investigated. (Figs. 37–41.)

Attached to the greater curvature of the stomach and continuous with one another from above downward are the gastrophrenic ligament, the

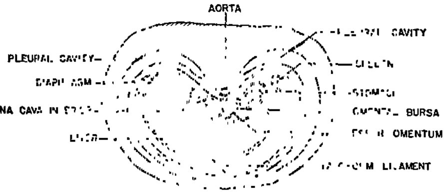

FIG. 38 —Diagrammatic transverse section through the abdominal cavity at the level of the superior recess of the omental bursa. The peritoneum is represented by the broken line.

lienogastric ligament, and the great omentum. The gastrophrenic ligament is a short peritoneal fold running from the upper part of the greater curvature to the peritoneum covering the diaphragm. It is continuous below with the lienogastric and lienorenal ligaments. The lienogastric ligament is a double fold of peritoneum running from the left portion of the greater curvature to the hilus of the spleen. Running backward from the hilus of the spleen to join the parietal peritoneum on the posterior wall of the peritoneal cavity is the lienorenal ligament, so called because it joins the posterior parietal peritoneum in front of the left kidney. The lienogastric and lienorenal ligaments become continuous below the spleen with the great omentum.

The great omentum is essentially a double fold of peritoneum stretching from the greater curvature of the stomach to the lower border of the transverse colon. It is, however, much longer than the distance between these

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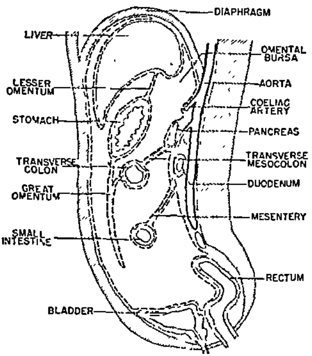
Pass the hand upward over the right side of the liver and identify the coronary ligament. This is a broad peritoneal fold through which the peritoneum on the upper and posterior surfaces of the liver becomes continuous with the peritoneum on the under surface of the diaphragm. Its sharp right free margin is known as the right triangular ligament. To the left of the attachment of the falciform ligament, connecting the diaphragmatic peritoneum with the peritoneum on the upper surface of the left lobe of the liver, is the narrow left triangular ligament.



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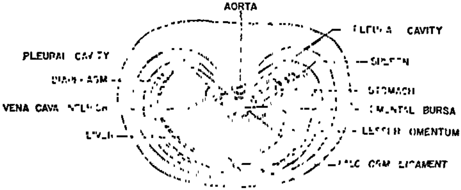

FIG. 38.—Diagrammatic transverse section through the abdominal cavity at the level of the superior recess of the omental bursa. The peritoneum is represented by the broken line.

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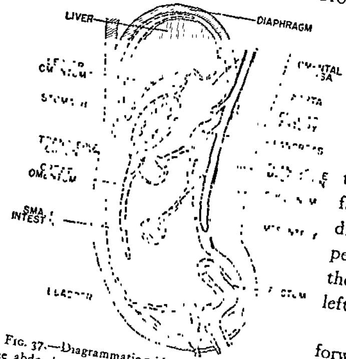

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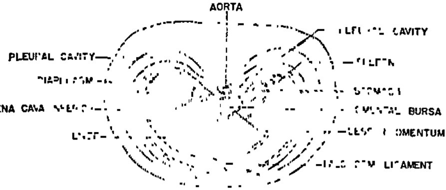

FIG 38.—Diagrammatic transverse section through the abdominal cavity at the level of the superior recess of the omental bursa. The peritoneum is represented by the broken line.

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two organs, so that it hangs down in the form of a great apron in front of the jejunum and ileum. The upper part of its right margin joins the duodenum just before that organ passes into the posterior wall of the peritoneal cavity.

The transverse mesocolon is a broad peritoneal ligament which runs upward and backward from the posterior surface of the transverse colon to the posterior wall of the peritoneal cavity. The parietal peritoneum on the posterior wall below the line of attachment of the transverse mesocolon is referred to as the descending layer of the transverse mesocolon, from the fact that it is continuous along this line of attachment with the posterior layer of the transverse mesocolon. Inferiorly the so-called descending layer

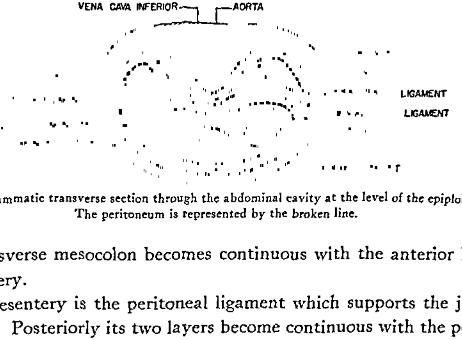

Fig. 39.—Diagrammatic transverse section through the abdominal cavity at the level of the epiploic foramen. The peritoneum is represented by the broken line.

of the transverse mesocolon becomes continuous with the anterior layer of the mesentery.

The mesentery is the peritoneal ligament which supports the jejunum and ileum. Posteriorly its two layers become continuous with the posterior parietal peritoneum, along an oblique line running downward and to the right from the duodeno-jejunal flexure to the ileo-coecal junction; anteriorly they become continuous with the visceral peritoneum clothing the jejunum and ileum. Its intestinal attachment is necessarily very much longer than its parietal attachment, giving the entire mesentery the form of a frill.

The ascending and descending colons have no mesenteries, being in contact posteriorly with the abdominal wall, and covered by peritoneum only anteriorly and on their sides. The coecum is usually attached to the posterior wall by a short mesocoecum; the vermiform appendix is usually also supported by a peritoneal fold, the mesappendix. The sigmoid colon is suspended from the parietal peritoneum of the left iliac fossa by a peri-

toneal fold, the sigmoid mesocolon, which crosses the pelvic brim to enter the pelvis. The phrenico-colic ligament is a small transverse shelf-like fold of peritoneum stretching from the lateral aspect of the upper part of the descending colon to the lower left portion of the diaphragm; the lower tip of the spleen usually rests upon its upper surface.

The portion of the peritoneal cavity which has so far been investigated is known as the greater peritoneal sac. There is another subdivision of the cavity, the lesser sac, or omental bursa, to which attention should now be turned. The omental bursa lies behind the lesser omentum, the stomach, and the upper anterior part of the great omentum. Its only communication with the greater sac is through an opening known as the epiploic foramen,

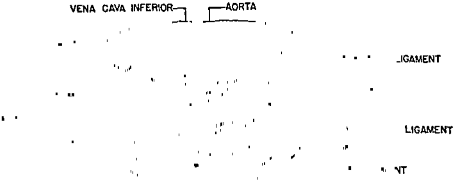

Fig. 40.—Diagrammatic transverse section through the abdominal cavity slightly below the level of the epiploic foramen. The peritoneum is represented by the broken line

which lies immediately behind the right free margin of the lesser omentum. If a finger is pushed upward and to the left along the inferior surface of the right lobe of the liver and behind the lesser omentum, it will pass through the epiploic foramen and enter the omental bursa. The epiploic foramen is bounded superiorly by peritoneum on the inferior surface of the liver, anteriorly by the posterior layer of the lesser omentum, inferiorly by the peritoneum on the first part of the duodenum, and posteriorly by parietal peritoneum which covers the vena cava inferior.

The omental bursa may now be opened from below by making an incision through the great omentum parallel to the greater curvature of the stomach and about half an inch below it; this incision should not be carried far enough to the left and upward to sever the gastrosplenic ligament. The boundaries of the omental bursa may then be explored through this opening.

Observe that the anterior wall of the omental bursa is formed from above downward by the lesser omentum, the posterior surface of the stomach, and

the upper anterior part of the great omentum. Its posterior wall is formed from below upward by the upper posterior part of the great omentum, the anterior surface of the transverse colon, the anterior surface of the transverse mesocolon, and the posterior parietal peritoneum above the parietal attachment of the transverse mesocolon. This portion of the parietal peritoneum is known as the ascending layer of the transverse mesocolon, from the fact that it is continuous at the line of parietal attachment of the transverse mesocolon with the anterior layer of that structure. The pancreas can usually be seen through the ascending layer of the transverse mesocolon,

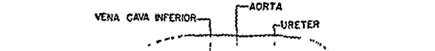

FIG 41.—Diagrammatic transverse section through the abdominal cavity at about the middle of the umbilical and lumbar regions. *The peritoneum is represented by the broken line.*

crossing the posterior abdominal wall just above the attachment of the transverse mesocolon.

At its upper right side the omental bursa communicates through the epiploic foramen with the greater sac. Below the foramen it is closed on the right by the attachment of the duodenum to the posterior abdominal wall, and the right closed margin of the great omentum. On its left side the bursa is separated from the great sac by the gastrophrenic ligament, the lienorenal and lienogastric ligaments, and the left margin of the great omentum. Occasionally the lower part of the omental bursa extends downward within the great omentum as far as its lower border. Usually, however, the anterior and posterior portions of the great omentum are firmly fused below, so that the cavity of the bursa rarely extends far below the lower border of the transverse colon. (Fig. 37.)

Attempt to identify the right and left gastro-pancreatic folds. These are anterior ridge-like projections into the cavity of the bursa, of the ascending layer of the transverse mesocolon. *Both start in the median line just* above the pancreas. The left fold runs upward and to the left to reach the

upper end of the lesser curvature of the stomach. The right fold runs downward and to the right to reach the lower right end of the lesser curvature.

The highest portion of the omental bursa is known as its superior recess. This is a narrow portion of the cavity lying behind the uppermost part of the lesser omentum. Observe that a small portion of the posterior surface of the right lobe of the liver projects into the superior recess. This is the caudate lobe of the liver and is the only part of the liver to be found in the wall of the omental bursa.

For further study of the stomach it will be found helpful to remove the left lobe of the liver. Make an incision through the left lobe starting anteriorly just to the left of the attachment of the falciform ligament and running straight backward to emerge just to the left of the attachment of the lesser omentum. To detach the left lobe from the diaphragm it will be necessary to cut also the left triangular ligament.

The stomach presents anterior and posterior surfaces which face respectively into the greater and lesser peritoneal sacs. Its borders are the curvatures already noted. The oesophagus joins the stomach at the cardia, just below the diaphragm. The body of the stomach is divided into cardiac and pyloric portions by a notch in the lesser curvature, the incisura angularis. The pyloric portion is the narrower lower third, which joins the duodenum. The expanded upper end of the cardiac portion is known as the fundus.

Cut through the peritoneum along the lesser and greater curvatures and clean the vessels which supply the stomach with blood. On the lesser curvature will be found the right and left gastric arteries and the coronary vein. On the greater curvature are the right and left gastro-epiploic and the short gastric arteries and veins. The origins of these vessels will be seen somewhat later; they should now be cleaned only in relation to the stomach. In spare subjects they may sometimes be seen through the peritoneum without dissection. (Fig. 42.)

The left gastric artery reaches the upper end of the lesser curvature by passing through the left gastro-pancreatic fold. It runs downward and to the right along the lesser curvature to anastomose with the right gastric. The right gastric appears at the right end of the lesser curvature and runs to the left to join the left gastric. The right gastro-epiploic should be found at the right end of the greater curvature and traced to the left, where it anastomoses with the left gastro-epiploic. The left gastro-epiploic reaches

the left side of the greater curvature by passing forward within the lienogastric ligament, and runs downward and to the right along the greater curvature. On the upper part of the greater curvature are the short gastric arteries, which also reach the stomach through the lienogastric ligament. All of these vessels give branches to both surfaces of the stomach. A branch of the left gastric passes upward to the oesophagus.

Remove the anterior layer of peritoneum from the right portion of the lesser omentum and expose and clean the structures which are contained within the lesser omentum in front of the epiploic foramen. These are the

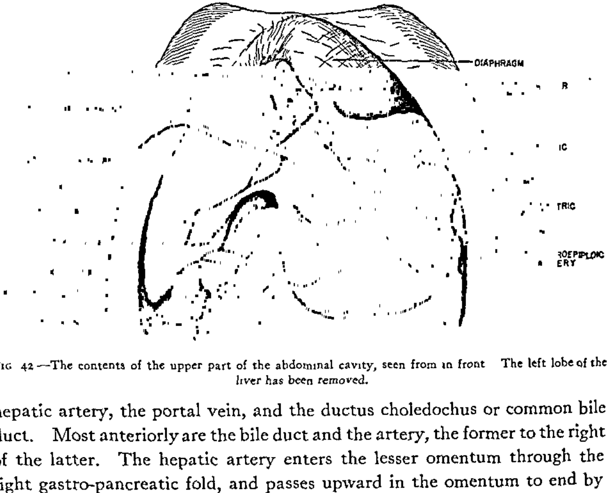

Fig 42.—The contents of the upper part of the abdominal cavity, seen from in front The left lobe of the liver has been removed.

hepatic artery, the portal vein, and the ductus choledochus or common bile duct. Most anteriorly are the bile duct and the artery, the former to the right of the latter. The hepatic artery enters the lesser omentum through the right gastro-pancreatic fold, and passes upward in the omentum to end by dividing into right and left hepatics, which enter the right and left lobes of the liver. As it reaches the lesser omentum it gives off the right gastric, whose entire course may now be seen, and the gastroduodenal artery, which passes downward behind the first part of the duodenum. The common bile duct is formed in the lesser omentum by the junction of the cystic duct and the hepatic duct. The cystic duct is the narrowed continuation of the gall bladder. It is accompanied by the cystic artery, a branch of the right

hepatic. The hepatic duct is formed by the junction of right and left hepatic ducts from the two lobes of the liver. The common bile duct leaves the lesser omentum by descending behind the first part of the duodenum.

The portal vein is a wide channel which lies behind the hepatic artery and the bile duct. It enters the lesser omentum from behind the first part of the duodenum. In the omentum it divides into right and left branches, which enter the lobes of the liver. Before its division it receives the coronary vein of the stomach, which enters the omentum through the right gastro-pancreatic fold.

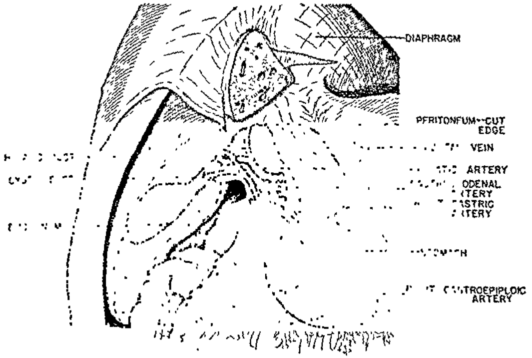

FIG. 43.—Dissection to display the structures contained within the right margin of the lesser omentum.

Cut the lesser omentum transversely and trace the hepatic artery back through the right gastro-pancreatic fold to its origin from the coeliac artery. Clean the coeliac artery. This is a short thick trunk which runs forward from the abdominal aorta just below the hiatus aorticus of the diaphragm, behind the peritoneum on the posterior wall of the omental bursa, to break up into three branches, the hepatic, the left gastric, and the splenic. Cut through the peritoneum of the left gastro-pancreatic fold and trace the left gastric artery to the point at which it reaches the stomach. Clean the beginning of the splenic artery and observe that it runs to the left along the upper border of the pancreas, behind the peritoneum on the posterior wall of the omental bursa. (Fig. 44.)

Cut through the duodenum just beyond its junction with the pylorus. Turn the pyloric end of the stomach to the left and trace the gastroduodenal artery down behind the first part of the duodenum, where it ends by dividing into the right gastroepiploic and the superior pancreatico-duodenal arteries. The latter will be traced later down along the medial border of the duodenum. The right gastroepiploic should now be followed to the point at which it reaches the greater curvature.

Next remove the stomach. To do this, cut through the cardiac end of the stomach close to its junction with the oesophagus. Then cut through the lesser omentum close to the lesser curvature, cutting at the same time the right and left gastric arteries as they reach the stomach. Carry another incision downward along the greater curvature through the gastrophrenic and lienogastric ligaments (which incision will also sever the short gastric and left gastro-epiploic arteries) to join the incision already made in the great omentum. Then sever the right gastro-epiploic artery where it reaches the greater curvature and remove the stomach. Open the stomach along the lesser curvature, wash out its contents, and examine the mucous membrane lining it.

Observe that the mucous membrane is pitted by minute depressions, which are more numerous toward the pylorus than at the fundus. Observe the rugae. These are projecting folds of the mucous membrane. In a distended stomach they are obliterated, but with contraction of the muscular wall of the stomach they appear, since the mucous membrane does not contract with the muscle.

The pyloric canal is the narrowed right end of the pylorus, leading to the pyloric orifice, the opening between the pylorus and the duodenum. Make a longitudinal section through the pyloric canal and study the pyloric sphincter. This is a thick circular ring of smooth muscle by which the pyloric orifice is kept closed, except when food is passing from the stomach to the duodenum.

Study the stomach bed. Stomach bed is the term used to designate the complex of structures upon which the posterior surface of the stomach rests. Observe that the lowest part of the stomach bed is formed by the transverse colon. Above this the posterior surface of the stomach rests upon the transverse mesocolon, through which it is in relation with the coils of the small intestine. Above the parietal attachment of the transverse mesocolon

the stomach bed is formed to the right by the parietal peritoneum on the posterior wall of the omental bursa and to the left by the gastric surface of the spleen. The latter is, however, kept from direct contact with the posterior surface of the stomach by the lienogastric and lienorenal ligaments.

Remove the parietal peritoneum forming the upper right portion of the stomach bed, and expose the retroperitoneal structures which are here in relation to the posterior surface of the stomach. Crossing the posterior abdominal wall immediately above the attachment of the transverse meso-

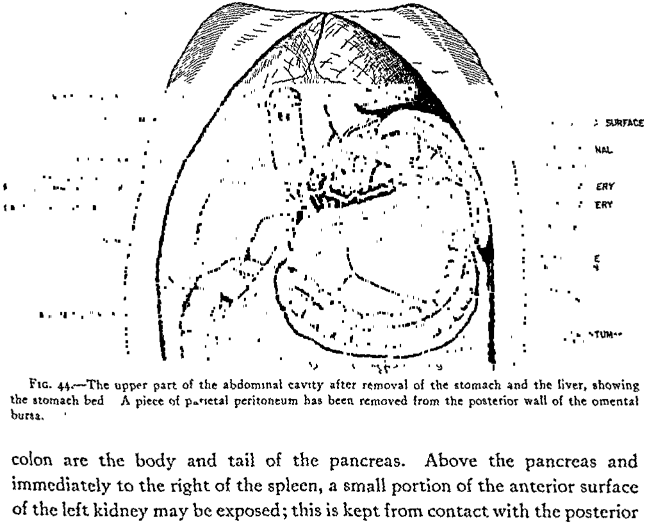

FIG. 44.—The upper part of the abdominal cavity after removal of the stomach and the liver, showing the stomach bed A piece of parietal peritoneum has been removed from the posterior wall of the omental bursa.

colon are the body and tail of the pancreas. Above the pancreas and immediately to the right of the spleen, a small portion of the anterior surface of the left kidney may be exposed; this is kept from contact with the posterior surface of the stomach only by the parietal peritoneum and some extraperitoneal areolar tissue. To the right of this area of kidney, the left suprarenal gland takes part in the formation of the stomach bed, and to the right of and above the suprarenal, the right crus of the diaphragm lies behind the highest part of the stomach.

Clean the splenic artery. It arises from the coeliac artery and crosses the posterior abdominal wall immediately above the pancreas, to which it

Cut through the duodenum just beyond its junction with the pylorus. Turn the pyloric end of the stomach to the left and trace the gastroduodenal artery down behind the first part of the duodenum, where it ends by dividing into the right gastroepiploic and the superior pancreatico-duodenal arteries. The latter will be traced later down along the medial border of the duodenum. The right gastroepiploic should now be followed to the point at which it reaches the greater curvature.

Next remove the stomach. To do this, cut through the cardiac end of the stomach close to its junction with the oesophagus. Then cut through the lesser omentum close to the lesser curvature, cutting at the same time the right and left gastric arteries as they reach the stomach. Carry another incision downward along the greater curvature through the gastrophrenic and lienogastric ligaments (which incision will also sever the short gastric and left gastro-epiploic arteries) to join the incision already made in the great omentum. Then sever the right gastro-epiploic artery where it reaches the greater curvature and remove the stomach. Open the stomach along the lesser curvature, wash out its contents, and examine the mucous membrane lining it.

Observe that the mucous membrane is pitted by minute depressions, which are more numerous toward the pylorus than at the fundus. Observe the rugae. These are projecting folds of the mucous membrane. In a distended stomach they are obliterated, but with contraction of the muscular wall of the stomach they appear, since the mucous membrane does not contract with the muscle.

The pyloric canal is the narrowed right end of the pylorus, leading to the pyloric orifice, the opening between the pylorus and the duodenum. Make a longitudinal section through the pyloric canal and study the pyloric sphincter. This is a thick circular ring of smooth muscle by which the pyloric orifice is kept closed, except when food is passing from the stomach to the duodenum.

Study the stomach bed. Stomach bed is the term used to designate the complex of structures upon which the posterior surface of the stomach rests. Observe that the lowest part of the stomach bed is formed by the transverse colon. Above this the posterior surface of the stomach rests upon the transverse mesocolon, through which it is in relation with the coils of the small intestine. Above the parietal attachment of the transverse mesocolon

it and the part of the posterior surface of the right lobe enclosed by the coronary ligament, the posterior surface of the liver partly encircles the vena cava inferior. All that remains to be done, in removing the liver, is to detach this portion of its posterior surface from the vena cava inferior. In doing this it will be necessary to sever the hepatic veins, three or four short trunks which pass from the substance of the liver directly into the vena cava. After the right lobe has been removed, reattach the left lobe to it with pins, and study the organ as a whole.

The liver is described as presenting anterior, superior, right lateral, posterior, and inferior surfaces. The inferior surface is clearly marked off from the anterior and the right lateral surfaces by a sharp inferior border; the other surfaces are for the most part separated from each other by less distinct, rounded borders. The superior, anterior, and right lateral surfaces are in contact with the diaphragm, and present a rounded contour corresponding to the form of that structure. Near the median line the inferior margin projects below the costal arch, bringing the lower part of the anterior surface into contact with the anterior abdominal wall.

The posterior surface of the liver is ordinarily described as including the bare area, the fossa for the vena cava, the caudate lobe, and a small upper right portion of the left lobe, which is in contact with the oesophagus. The bare area is the large triangular area of the right lobe, which is enclosed by the coronary and right triangular ligaments. It is in direct contact with the diaphragm, without the intervention of any peritoneum. Below and to the left this area is in contact with the right suprarenal gland, which here intervenes between the diaphragm and the liver. Dissect in the region from which the bare area was removed, and expose the anterior surface of the right suprarenal. (Fig. 44.) Occasionally the uppermost portion of the anterior surface of the right kidney is high enough also to come into relation with the bare area.

The fossa for the vena cava lies immediately to the left of the bare area. It sometimes almost entirely surrounds the vessel. Opening into it the cut ends of the hepatic veins will be seen.

The caudate lobe lies between the fossa for the vena cava and the attachment of the lesser omentum. It is covered with visceral peritoneum and, as already observed, it projects into the superior recess of the omental bursa.

gives numerous small branches. It passes between the two layers of the lienorenal ligament to reach the hilus of the spleen, where it terminates by dividing into three or four branches which enter the spleen, and the left gastro-epiploic and short gastric arteries, which pass forward through the lienogastric ligament to reach the stomach. The course of the splenic artery across the posterior abdominal wall is usually rather tortuous.

Study the spleen. This organ is completely clothed with visceral peritoneum, except at its hilus, where it is joined by the lienorenal and lienogastric ligaments. It presents two primary surfaces, an outer or diaphragmatic and an inner or visceral. The diaphragmatic surface is smooth and convex and is in relation to the upper left portion of the diaphragm. The visceral surface is subdivided into three smaller surfaces, all of which converge toward the hilus. The largest and most anterior is the gastric surface, which is somewhat concave, and forms, as has already been seen, a portion of the stomach bed. The upper posterior portion of the visceral surface is the renal surface. This is in relation to the upper left portion of the anterior surface of the left kidney, from which it is separated by peritoneum and extra-peritoneal areolar tissue. The lowest portion of the visceral surface is the colic surface. This is in contact with the left colic flexure and the phrenico-colic ligament.

The left lobe of the liver has already been removed. The right lobe should now be removed, for study of the surfaces of the liver. Cut through the falciform ligament, from its free margin up to the point at which it joins the coronary and left triangular ligaments. Cut the right triangular ligament transversely and continue this incision to the left through the superior layer of the coronary ligament to the point at which it joins the falciform ligament. As they pass to the left from the right triangular ligament, the superior and inferior layers of the coronary ligament diverge, inclosing a broad area on the posterior surface of the right lobe of the liver, which is not covered with peritoneum. Free this area from the diaphragm and cut through the inferior layer of the coronary ligament. Sever the hepatic artery and the portal vein just below their division into right and left branches; cut the common bile duct at the same level.

The caudate lobe of the liver has already been observed as a free portion of the posterior surface of the right lobe projecting into the upper part of the omental bursa. Immediately to the right of the caudate lobe, between

it and the part of the posterior surface of the right lobe enclosed by the coronary ligament, the posterior surface of the liver partly encircles the vena cava inferior. All that remains to be done, in removing the liver, is to detach this portion of its posterior surface from the vena cava inferior. In doing this it will be necessary to sever the hepatic veins, three or four short trunks which pass from the substance of the liver directly into the vena cava. After the right lobe has been removed, reattach the left lobe to it with pins, and study the organ as a whole.

The liver is described as presenting anterior, superior, right lateral, posterior, and inferior surfaces. The inferior surface is clearly marked off from the anterior and the right lateral surfaces by a sharp inferior border; the other surfaces are for the most part separated from each other by less distinct, rounded borders. The superior, anterior, and right lateral surfaces are in contact with the diaphragm, and present a rounded contour corresponding to the form of that structure. Near the median line the inferior margin projects below the costal arch, bringing the lower part of the anterior surface into contact with the anterior abdominal wall.

The posterior surface of the liver is ordinarily described as including the bare area, the fossa for the vena cava, the caudate lobe, and a small upper right portion of the left lobe, which is in contact with the oesophagus. The bare area is the large triangular area of the right lobe, which is enclosed by the coronary and right triangular ligaments. It is in direct contact with the diaphragm, without the intervention of any peritoneum. Below and to the left this area is in contact with the right suprarenal gland, which here intervenes between the diaphragm and the liver. Dissect in the region from which the bare area was removed, and expose the anterior surface of the right suprarenal. (Fig. 44.) Occasionally the uppermost portion of the anterior surface of the right kidney is high enough also to come into relation with the bare area.

The fossa for the vena cava lies immediately to the left of the bare area. It sometimes almost entirely surrounds the vessel. Opening into it the cut ends of the hepatic veins will be seen.

The caudate lobe lies between the fossa for the vena cava and the attachment of the lesser omentum. It is covered with visceral peritoneum and, as already observed, it projects into the superior recess of the omental bursa.

The inferior surface of the liver is actually postero-inferior in position. The inferior surface of the left lobe is in contact with the lesser omentum and the upper part of the anterior surface of the stomach. The inferior surface of the right lobe exhibits numerous impressions corresponding to the structures which which it is in relation.

Closely applied to the inferior surface of the right lobe is the gall-bladder. Superiorly the gall-bladder is in direct contact with the liver substance; at its sides the visceral peritoneum covering the inferior surface of the liver is reflected over the gall-bladder, giving the free surface of the gall-bladder a serous coat of visceral peritoneum. Running to the left from the gall-bladder into the lesser omentum is the cystic duct.

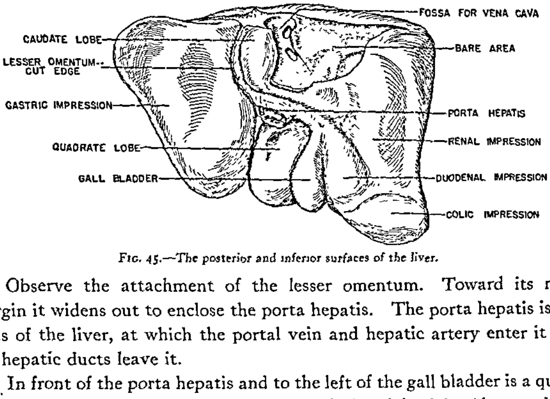

Fig. 45.—The posterior and inferior surfaces of the liver.

Observe the attachment of the lesser omentum. Toward its right margin it widens out to enclose the porta hepatis. The porta hepatis is the hilus of the liver, at which the portal vein and hepatic artery enter it and the hepatic ducts leave it.

In front of the porta hepatis and to the left of the gall bladder is a quadrangular portion of the inferior surface of the right lobe, the quadrate lobe. It is in contact with the pylorus and the beginning of the duodenum. Immediately to the right of the constricted portion of the gall bladder is a variable duodenal impression. The part of the inferior surface which is most anterior and farthest to the right exhibits a colic impression, where the liver is in contact with the right colic flexure. Above and behind the colic impression, and occasionally extending on to the bare area, is the broad renal impression. Here the right lobe of the liver is in relation to the anterior surface of the right kidney, but separated from it by a layer of parietal peritoneum.

Open the gall bladder by a longitudinal incision running from the fundus to the neck and examine its interior. The interior of the gall bladder is stained dark green with bile. Observe that the lining membrane presents a ridged appearance, and that toward the neck the ridges take on a spiral form. This is the so-called spiral valve of the gall bladder, which is continued well into the cystic duct.

Detach the left lobe of the liver once more and study the cut surface of the organ. The larger cut vessels which will be seen are branches of the portal vein and tributaries of the hepatic veins. These two sets of veins can always be distinguished from each other by the fact that each branch of the portal vein is accompanied by a branch of the hepatic artery and a tributary of the bile duct. In addition to this, these three structures are enclosed in a fibrous sheath, constituting a portal canal, while the hepatic veins have very thin walls and appear to be in direct contact with the liver substance.

Turn the transverse colon and transverse mesocolon upward, draw the coils of jejunum and ileum downward and to the left, so that the right surface of the mesentery faces anteriorly, and clean and study the superior mesenteric vessels. To do this it will be necessary to remove a large continuous piece of peritoneum constituting the posterior layer of the transverse mesocolon, the right layer of the mesentery, and the portion of the parietal peritoneum of the posterior abdominal wall which intervenes between these two mesenteries on the right side. The removal of this portion of the parietal peritoneum will expose the anterior aspect of the terminal part of the duodenum, and enclosed within the bend of the duodenum, the lower part of the anterior surface of the head and neck of the pancreas. (Fig. 46.)

The superior mesenteric artery arises from the front of the abdominal aorta a short distance below the coeliac artery. It enters the present area of dissection by passing downward behind the neck of the pancreas and in front of the lower part of the duodenum. The superior mesenteric vein lies to the right of the artery and often overlaps it anteriorly. The tributaries of the vein, which correspond to the branches of the artery, may be removed in cleaning the arteries but the trunk of the vein should be retained.

In front of the lower part of the duodenum the superior mesenteric artery reaches the root of the mesentery. It then runs downward and to the right across the posterior abdominal wall along the root of the mesentery.

Its terminal portion enters the mesentery, to reach the lower part of the ileum.

The first branch of the superior mesenteric, the inferior pancreatico-duodenal, is at present hidden by the pancreas. Just below the pancreas the superior mesenteric gives rise to the middle colic artery. This vessel enters the transverse mesocolon, where it divides into right and left branches, which supply the transverse colon. Somewhat lower is the right colic artery,

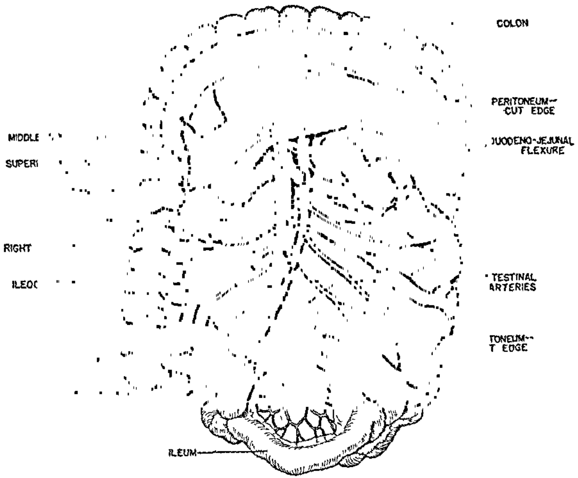

FIG. 46—Dissection to display the superior mesenteric artery and its branches.

which crosses the right side of the posterior abdominal wall behind the parietal peritoneum and divides into ascending and descending branches which supply the ascending colon; the ascending branch anastomoses with the right branch of the middle colic. Arising usually somewhat below the right colic, but sometimes by a common stem with it, is the ileocolic branch. This runs downward and to the right across the posterior abdominal wall, to give branches to the coecum, appendix, and terminal part of the ileum. Its terminal branches anastomose with each other and with the descending branch of the right colic.

In its passage along the root of the mesentery the superior mesenteric artery gives rise to a series of from twelve to sixteen intestinal arteries, which run forward through the mesentery to supply the jejunum and ileum. Each intestinal artery divides into two branches, which unite with similar branches from adjacent arteries to form a series of arterial loops or arcades in the mesentery. From these arcades other branches arise, which also unite to form smaller arches as they approach the intestine. Observe the manner in which these arterial arcades change, from the upper to the lower end of the mesentery. In the upper part of the mesentery there is usually only one set of arterial arches, giving branches directly to the gut, while toward the lower end of the ileum there may be as many as four or five sets of arches. Observe also that the amount of fat contained within the mesentery, around the arterial arches, increases from above downward; if the mesentery is held up to light, large tanslucent areas may be seen within the arterial arches of its upper portion, while in the lower portion the translucent areas are much smaller, due to the larger amount of fat present.

Study the jejunum and ileum. These are the intraperitoneal portions of the small intestine. Together they measure on the average about twenty-two feet in length. The division between jejunum and ileum is an arbitrary one, the jejunum being the upper two fifths and the ileum the lower three fifths. It is based on the fact that there is a gradual change in the character of the intestinal wall from the duodeno-jejunal flexure to the ileo-colic junction, so that the lower end of the ileum exhibits some very different characteristics from the upper end of the jejunum.

Section the jejunum about an inch below the duodeno-jejunal flexure; section the ileum about an inch from its junction with the coecum; cut through the mesentery along the entire length of its intestinal attachment, and remove the jejunum and ileum. Open the gut by longitudinal incisions in the wall at intervals along its length, and compare the characteristics of its lining in different regions.

Observe that the circular folds of the mucous membrane are largest and closest together in the upper part of the jejunum and almost entirely lacking in the lower part of the ileum. The wall of the jejunum is in general somewhat thicker than that of the ileum. Attempt to find some aggregate lymph-nodules. These are collections of solitary lymph-nodules, occurring in oval patches which may be as much as five or six centimeters in length.

left from the upper part of the head, to join the body. It rests posteriorly against the beginning of the portal vein.

The body of the pancreas runs to the left and somewhat upward across the posterior abdominal wall. It presents an anterior surface, a posterior surface, and a narrow inferior surface. The line of attachment of the transverse mesocolon usually follows the border separating anterior and inferior surfaces, so that the former faces into the omental bursa, and comes into relation, through the peritoneum covering it, with posterior surface of the stomach. The inferior surface of the pancreas faces downward into the greater sac. The posterior surface has no relation to peritoneum, and crosses the aorta and the upper part of the superior mesenteric artery; it is in relation also to the anterior surface of the left kidney. The tail of the pancreas is the narrowed left extremity of the body. It usually extends forward through the lienorenal ligament, to come into contact with the hilus of the spleen.

Detach the tail, body, and neck of the pancreas from the posterior abdominal wall and turn them forward and to the right to expose the structures behind them. Observe that the splenic vein runs to the right behind the upper border of the pancreas. The splenic vein is formed at the hilus of the spleen by the junction of the short gastric and left gastro-epiploic veins and several veins from the spleen. It traverses the lieno-renal ligament and passes to the right across the posterior abdominal wall. Behind the neck of the pancreas it joins the superior mesenteric vein to form the portal vein, which then passes upward behind the first part of the duodenum and into the lesser omentum. Clean the terminal portion of the inferior mesenteric vein, which ascends behind the pancreas to join the splenic vein. Occasionally it lies farther to the right, opening into the superior mesenteric vein near the termination of the latter. The left renal vein may usually also be seen behind the body of the pancreas, crossing from the left kidney to the vena cava inferior, in front of the aorta and behind the superior mesenteric artery. (Fig. 47.)

Clean the pancreatico-duodenal arteries. The origin of the superior pancreatico-duodenal behind the superior part of the duodenum as a branch of the gastro-duodenal has already been seen. Trace it downward along the medial border of the pars descendens, where it will be found to give branches to the duodenum and the head of the pancreas. The inferior pancreatico-duodenal artery arises from the superior mesenteric near the lower border

of the pancreas. It runs downward and to the right between the pars inferior of the duodenum and the head of the pancreas, giving branches to both, and ends by anastomosing with the superior pancreatico-duodenal. The inferior pancreatico-duodenal occasionally arises as a branch of the first intestinal branch of the superior mesenteric.

The common bile duct has already been seen to be formed within the right margin of the lesser omentum by the junction of the cystic and hepatic ducts, and to descend behind the first part of the duodenum. Trace it now downward between the descending part of the duodenum and the head of the pancreas to the point at which it enters the wall of the duodenum. In the wall of the duodenum it is joined by the main duct of the pancreas.

Dissect in the substance of the pancreas and clean and study its ducts. The pancreatic ducts lie nearer to the posterior than the anterior surface of the gland and can consequently be more readily exposed from behind. The ducts are small and thin-walled and usually white or grey in color. The main duct begins in the tail of the pancreas and passes to the right through the body, receiving small ducts from the numerous lobules along its course. It then passes downward and to the right through the neck and head and joins the common bile duct in the medial wall of the descending part of the duodenum. The accessory duct is smaller; it begins in the lower part of the head and runs upward through the substance of the pancreas to open into the descending part of the duodenum above the main duct, which it crosses in its course. The two ducts often communicate within the substance of the pancreas.

Open the duodenum by a longitudinal incision in the anterior wall of the descending portion, and study its interior. Observe that the circular folds of the mucosa are large and numerous. Find the duodenal papilla. This is a small elevation at about the middle of the medial wall of the descending portion of the duodenum, at the summit of which is the common orifice of the main pancreatic and common bile ducts. The papilla is usually at the upper end of a longitudinal fold of the mucosa, the plica longitudinalis.

Remove the parietal peritoneum from the lower left portion of the posterior abdominal wall, between the descending colon and the root of the mesentery, and clean and study the inferior mesenteric vessels. (Fig. 47.)

The inferior mesenteric artery is much smaller than the superior mesenteric. It arises from the front of the lower part of the abdominal aorta and

left from the upper part of the head, to join the body. It rests posteriorly against the beginning of the portal vein.

The body of the pancreas runs to the left and somewhat upward across the posterior abdominal wall. It presents an anterior surface, a posterior surface, and a narrow inferior surface. The line of attachment of the transverse mesocolon usually follows the border separating anterior and inferior surfaces, so that the former faces into the omental bursa, and comes into relation, through the peritoneum covering it, with posterior surface of the stomach. The inferior surface of the pancreas faces downward into the greater sac. The posterior surface has no relation to peritoneum, and crosses the aorta and the upper part of the superior mesenteric artery; it is in relation also to the anterior surface of the left kidney. The tail of the pancreas is the narrowed left extremity of the body. It usually extends forward through the lienorenal ligament, to come into contact with the hilus of the spleen.

Detach the tail, body, and neck of the pancreas from the posterior abdominal wall and turn them forward and to the right to expose the structures behind them. Observe that the splenic vein runs to the right behind the upper border of the pancreas. The splenic vein is formed at the hilus of the spleen by the junction of the short gastric and left gastro-epiploic veins and several veins from the spleen. It traverses the lieno-renal ligament and passes to the right across the posterior abdominal wall. Behind the neck of the pancreas it joins the superior mesenteric vein to form the portal vein, which then passes upward behind the first part of the duodenum and into the lesser omentum. Clean the terminal portion of the inferior mesenteric vein, which ascends behind the pancreas to join the splenic vein. Occasionally it lies farther to the right, opening into the superior mesenteric vein near the termination of the latter. The left renal vein may usually also be seen behind the body of the pancreas, crossing from the left kidney to the vena cava inferior, in front of the aorta and behind the superior mesenteric artery. (Fig. 47.)

Clean the pancreatico-duodenal arteries. The origin of the superior pancreatico-duodenal behind the superior part of the duodenum as a branch of the gastro-duodenal has already been seen. Trace it downward along the medial border of the pars descendens, where it will be found to give branches to the duodenum and the head of the pancreas. The inferior pancreatico-duodenal artery arises from the superior mesenteric near the lower border

the upper medial portion of the anterior surface of each kidney is in direct contact with the posterior surface of the suprarenal.

The anterior surface of the right kidney is in direct contact near its medial border with the descending portion of the duodenum. To the right of this it presents a broad area which is in relation through the parietal peritoneum with the inferior surface of the liver. Below the liver this surface

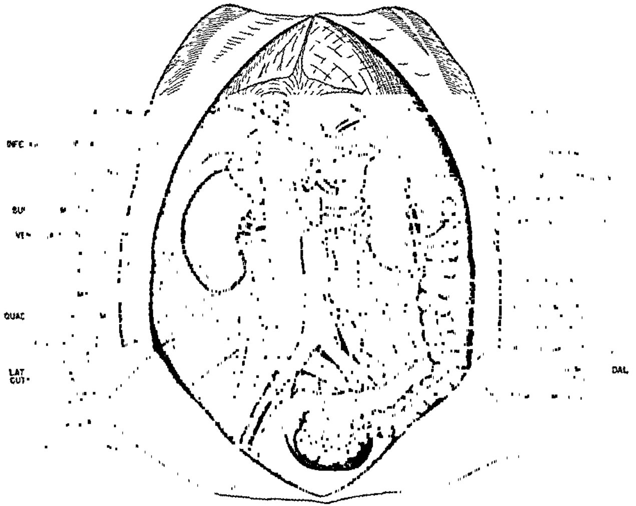

FIG. 47.—Dissection of the retro-peritoneal structures on the posterior abdominal wall.

is in contact, without the intervention of any peritoneum, with the right colic flexure. The lowest and most medial portion of the anterior surface of the right kidney comes into relation, through the peritoneum, with the coils of the small intestine.

The left kidney is crossed anteriorly by the pancreas. Above the pancreas it is in relation with the renal surface of the spleen and the posterior surface of the stomach, from both of which it is separated by parietal peritoneum. Below the pancreas it is in relation to the right with coils of small intestine, and to the left with the left colic flexure.

runs downward and to the left behind the peritoneum on the posterior abdominal wall. Its first branch is the left *colic artery.* This vessel runs to the left behind the peritoneum and divides into ascending and descending branches, which supply the descending colon; the ascending branch anastomoses with the left branch of the middle colic artery. Below the left colic, several sigmoid branches arise from the inferior mesenteric. These pass forward in the sigmoid mesocolon to supply the sigmoid colon. They form anastomosing loops with one another, with the descending branch of the left colic, and with the superior haemorrhoidal artery. The superior haemorrhoidal is the direct continuation of the inferior mesenteric, which crosses the pelvic brim to enter the pelvis minor.

The tributaries of the inferior mesenteric vein correspond to the branches of the artery. The trunk of the vein does not, however, accompany the artery, but ascends behind the peritoneum on the left side of the posterior abdominal wall, to pass behind the pancreas and join the splenic vein.

Carefully remove the spleen, pancreas, and duodenum and any portions of the mesentery and of the transverse mesocolon which may remain, and clean the anterior aspects of the kidneys and the suprarenal glands; these retroperitoneal structures are often covered anteriorly by a fairly thick layer of fatty areolar tissue.

The *suprarenal glands are of irregular shape and are flattened antero*posteriorly. The left suprarenal is in relation anteriorly with the posterior surface of the stomach, through the parietal peritoneum of the stomach bed; the lower part of its anterior surface often lies behind the pancreas. The anterior surface of the right suprarenal is overlapped on the left by the vena cava inferior, but is elsewhere in contact with the liver.

The lower lateral portion of the posterior surface of each suprarenal is in contact with the upper medial part of the anterior surface of the corresponding kidney; above the kidney each suprarenal rests posteriorly against the diaphragm.

The height to which the kidneys rise in the abdominal cavity is somewhat variable, a circumstance which can be readily understood from a knowledge of the embryology of these organs. In most cases, however, the lower pole of each kidney lies well above the iliac crest. The organs with which the anterior surfaces of the kidneys come into relation have for the most part been removed, but the relations should now be reviewed. Observe that

the upper medial portion of the anterior surface of each kidney is in direct contact with the posterior surface of the suprarenal.

The anterior surface of the right kidney is in direct contact near its medial border with the descending portion of the duodenum. To the right of this it presents a broad area which is in relation through the parietal peritoneum with the inferior surface of the liver. Below the liver this surface

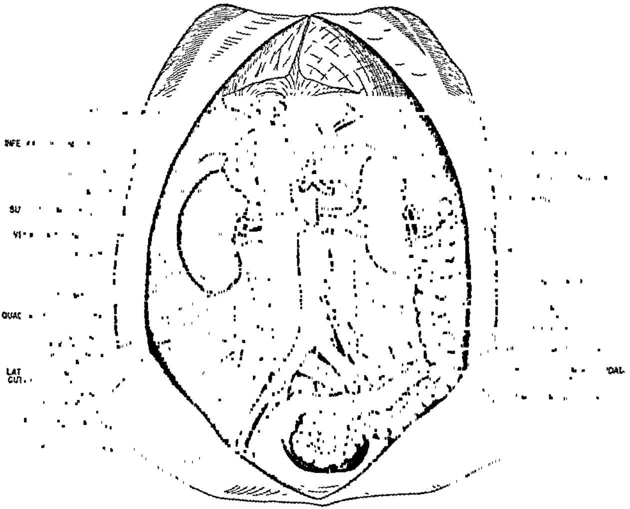

Fig. 47.—Dissection of the retro-peritoneal structures on the posterior abdominal wall.

is in contact, without the intervention of any peritoneum, with the right colic flexure. The lowest and most medial portion of the anterior surface of the right kidney comes into relation, through the peritoneum, with the coils of the small intestine.

The left kidney is crossed anteriorly by the pancreas. Above the pancreas it is in relation with the renal surface of the spleen and the posterior surface of the stomach, from both of which it is separated by parietal peritoneum. Below the pancreas it is in relation to the right with coils of small intestine, and to the left with the left colic flexure.

The relations of the posterior surfaces of the kidneys can be better appreciated when the posterior abdominal wall has been studied. For the present it is sufficient to observe that the posterior surfaces of the kidneys have no relation to peritoneum, and that each is in contact above with the diaphragm, and below with the muscles of the posterior abdominal wall.

The hilus of each kidney is an oval area at the middle of its medial border, where the renal artery enters it and the renal vein and the ureter leave it. The renal arteries are branches of the abdominal aorta; the renal veins drain into the vena cava inferior. Near the hilus the vein is usually the most anterior and the ureter the most posterior of the three structures, but this relation is not constant. Observe that the left renal vein crosses anterior to the aorta and the right renal artery posterior to the vena cava. It is not uncommon to find more than one artery passing from the aorta to the kidney on one or both sides. As it emerges from the hilus, the ureter is wide. Its diameter contracts and it passes downward and medially across the posterior abdominal wall toward the pelvic brim.

Without severing the renal vessels or the ureter, make a longitudinal section through the right kidney from the lateral border to the hilus, and study the cut surfaces. Observe that the kidney substance exhibits a differentiation into two parts, cortex and medulla. The cortex is the lighter colored peripheral portion. The inner or medullary portion is made up of a variable number of renal papillae which project into the renal sinus, the hollow portion of the kidney lying just internal to the hilus. The membrane lining the renal sinus is the renal pelvis; this becomes continuous at the hilus with the expanded upper portion of the ureter. The uriniferous tubules open into the renal pelvis at the apices of the papillae.

Clean and study the coeliac plexus. This is a nerve plexus of the autonomic system, which receives fibres from the vagi and from the sympathetic trunks; the latter reach it through the greater and lesser splanchnic nerves. It consists of the two coeliac ganglia and their branches of communication. Each coeliac ganglion is in reality a group of several closely connected ganglia. (Fig. 47.)

The left coeliac ganglion lies on the left crus of the diaphragm, between the aorta and the left suprarenal gland. Cut carefully into the substance of the diaphragm to [illegible]se the left greater splanchnic nerve, which pierces the diaphragm to [illegible] gan[illegible]

The right coeliac ganglion occupies a similar position on the right side, but is for the most part covered anteriorly by the vena cava inferior. The right and left ganglia are connected by branches which pass transversely, above and below the coeliac artery. The branches of distribution of the coeliac plexus are the various sympathetic plexuses which accompany the abdominal aorta and its branches.

Clean and study the abdominal aorta and the vena cava inferior. In cleaning the aorta observe the aortic plexus. This is a sympathetic nerve plexus which is connected above with the coeliac plexus, and also receives branches from the lumbar portion of the sympathetic trunk. From it subordinate plexuses arise, which accompany the branches of the aorta to the viscera.

The abdominal aorta begins at the hiatus aorticus of the diaphragm, as a continuation of the descending portion of the thoracic aorta. It descends in front of the bodies of the first four lumbar vertebrae, to end, usually in front of the fourth lumbar, by dividing into the right and left common iliac arteries. Anteriorly and to the left it is in relation to the parietal peritoneum of the posterior abdominal wall, except where other structures intervene between the aorta and the peritoneum. These structures are the pancreas, the inferior part of the duodenum, the splenic vein, the left renal vein, and portions of some of its own branches. To the right it is in relation with the vena cava inferior, with the exception that its most superior portion is separated from the vena cava by the right crus of the diaphragm.

The unpaired branches which arise from the anterior aspect of the aorta have already been studied. The paired branches, which should now be investigated, are the inferior phrenic, the middle suprarenal, the renal, the internal spermatic (or ovarian), and the common iliac arteries. (Fig. 47.)

The inferior phrenic arteries arise from the aorta between the two crura of the diaphragm. They pass upward and laterally across the inferior surface of the diaphragm. Observe that the right artery passes behind the vena cava inferior and the left behind the oesophagus. One or both of the inferior phrenics may be found to arise from the coeliac; the left inferior phrenic occasionally arises from the left gastric. The inferior phrenic usually gives a superior suprarenal branch to the suprarenal gland.

The middle suprarenal arteries are small vessels, not always present, which arise from the lateral aspects of the aorta at about the same level as

the origin of the superior mesenteric. They cross the crura of the diaphragm to reach the suprarenal glands.

The *renal arteries* have already been observed as large lateral branches of the aorta, which supply the kidneys. Before it reaches the hilus of the kidney, each renal artery usually gives an inferior suprarenal branch to the suprarenal gland. The right renal artery crosses behind the vena cava inferior.

The internal spermatic arteries arise from the front of the aorta somewhat below the origin of the superior mesenteric. They pass downward and laterally across the posterior abdominal wall to reach the abdominal inguinal ring, from which point their further course has already been seen. In its passage across the posterior abdominal wall the internal spermatic artery crosses in front of the ureter. The ovarian arteries are the homologues in the female of the internal spermatics of the male. Superiorly their course is similar; inferiorly, however, they do not diverge so far laterally, but cross in front of the common iliac arteries to enter the pelvis minor.

The *common iliac arteries* are short thick trunks which run downward and laterally from the termination of the aorta, to end opposite the lumbosacral articulation by dividing into the external iliac and the hypogastric arteries. They have no other branches. Observe that the left common iliac artery is crossed anteriorly by the superior haemorrhoidal vessels and that each common iliac is crossed anteriorly by the ureter, and in the female by the ovarian vessels.

In addition to the branches described above, there arise from the posterior aspect of the abdominal aorta four pairs of lumbar arteries and a single middle sacral artery. The lumbar arteries may be studied to better advantage somewhat later; the middle sacral may be found now, emerging from behind the left common iliac vein and running downward in front of the body of the fifth lumbar vertebra into the pelvis.

The vena cava inferior is formed, to the right of the body of the fifth lumbar vertebra and behind the right common iliac artery, by the junction of the right and left common iliac veins. The common iliac veins are at their origin somewhat medial and posterior to the terminations of the common iliac arteries. Observe that the left common iliac vein is considerably longer than the right. It runs upward, medial to the left common iliac artery, to

join the right vein behind the right common iliac artery, receiving in its course the middle sacral vein.

From its origin the vena cava ascends on the posterior abdominal wall to an orifice in the tendinous portion of the diaphragm. It lies in front of the right sides of the bodies of the lumbar vertebrae and the medial border of the right psoas major muscle. Its upper portion rests posteriorly against the diaphragm. Here it is elsewhere in contact with the liver, as previously observed. Below the liver it is in relation anteriorly and to the right with the parietal peritoneum, except where it is covered by the pancreas and duodenum. The largest tributaries of the vena cava inferior, above the common iliac veins, are the renal veins. Observe that while the vena cava receives directly the right suprarenal and right internal spermatic (or ovarian) veins, the left suprarenal and left internal spermatic veins join the left renal vein. The vena cava receives also the inferior phrenic veins and three or four hepatic veins.

Section the vena cava just below the diaphragm and again about half an inch above its origin. Draw the cut segment forward, and dissecting carefully behind it, attempt to determine how many of the lumbar veins join it. There are four pairs of lumbar veins, corresponding to the lumbar arteries, but they do not always all join the vena cava. The upper ones usually drain into the right and left ascending lumbar veins, which pass through the diaphragm as the azygos and hemiazygos veins respectively. Divide the lumbar veins at their junction with the vena cava and remove the cut segment of vena cava. Sever the renal arteries and the ureters close to the hilus of the kidney, and remove the kidneys and the suprarenals at the same time.

Study the diaphragm. This is the great dome-like sheet of muscular and fibrous tissue which separates the thoracic and abdominal cavities. It consists of a peripheral muscular portion and a central tendinous portion. The muscle fibres which constitute the peripheral portion are described as taking origin at their peripheral attachments and as being inserted into the central tendon. Starting anteriorly the origin of the diaphragm is by two small slips from the back of the xiphoid process; then on either side by a series of six slips from the inner surfaces of the cartilages of the lower six ribs, which interdigitate with the slips of origin of the transversus abdominis;

between the cartilage of the twelfth rib and the vertebral column the diaphragm takes origin from the lateral and medial lumbo-costal arches; its most posterior portion arises from the lumbar vertebrae by means of the right and left crura.

The posterior abdominal wall, below the diaphragm and lateral to the vertebral column, is formed by the psoas major and quadratus lumborum muscles. The lumbo-costal arches are thickenings in the fascia covering the anterior surfaces of these muscles. They can not always be demonstrated as distinct structures, but the origin of the diaphragm from the quadratus and psoas fascia is perfectly constant. The medial lumbo-costal arch typically crosses the psoas major from the body to the transverse process of the second lumbar vertebra; the lateral arch crosses the quadratus from the same transverse process to the twelfth rib. (Fig. 48.)

The crura are the thickest and most fleshy portions of the diaphragm. The right crus is larger and descends lower than the left; it arises from the bodies of the first three lumbar vertebrae. The left crus arises from only the first two lumbar vertebrae. The lowest portions of both crura are tendinous. As they ascend, the crura approach each other and their fibres cross and mingle with each other in front of the aorta. Observe that the hiatus aorticus is thus not an actual opening in the diaphragm, but a passage behind it. The aorta is protected from constriction when the diaphragm contracts by a fibrous arch which connects the medial borders of the two crura in front of the aorta and forms the actual border of the hiatus aorticus.

Clean and study the psoas and quadratus muscles. In cleaning the psoas watch for the genitofemoral nerve, which emerges through its substance, and runs downward and laterally on the anterior surface of the muscle. In cleaning the quadratus, preserve the sub-costal, iliohypogastric, and ilioinguinal nerves, all of which will be found emerging from behind the lateral border of the psoas and crossing the anterior surface of the quadratus.

First observe whether or not the psoas minor is present. This small muscle arises from the sides of the bodies of the twelfth thoracic and first lumbar vertebrae. Its fleshy body narrows to a flat tendon which passes down on the anterior surface of the psoas major to be inserted on the pecten of the pubis. It is very often lacking on one or both sides.

The psoas major arises by a series of fleshy bundles from the intervertebral discs of all the lumbar vertebrae and from a series of fibrous arches

which bridge across the sides of the bodies of the lumbar vertebrae between the discs. Observe that the lumbar arteries pass around the sides of the bodies of the upper four lumbar vertebrae behind these fibrous arches. The psoas major also has a deep origin from the transverse processes of the lumbar vertebrae. The muscle fibres form a fusiform belly, which crosses the ilium above the brim of the pelvis, where it lies lateral to the external

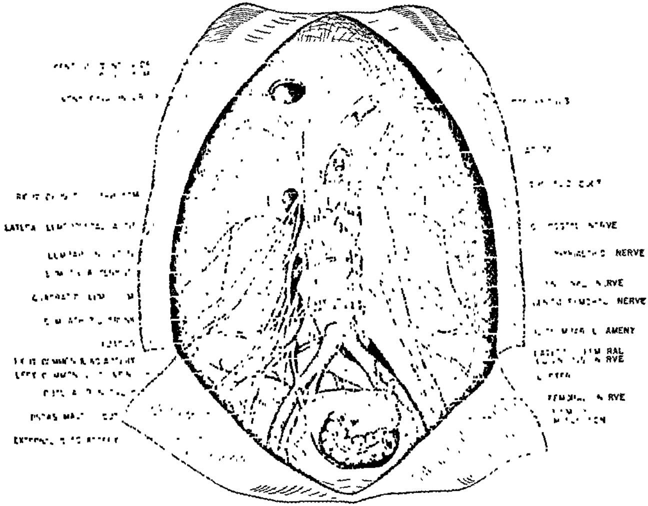

FIG. 48.—Dissection of the posterior abdominal wall. The psoas major has been removed on the right side, to display the lumbar plexus.

iliac artery. It leaves the abdomen by passing behind the inguinal ligament into the thigh, where it is inserted on the lesser trochanter of the femur.

The quadratus lumborum is a flat muscle lying lateral to the upper part of the psoas major, between the twelfth rib and the iliac crest. It arises from the posterior part of the internal lip of the iliac crest, from the ilio-lumbar ligament, the transverse processes of the lower three or four lumbar vertebrae, and the deep surface of the anterior lamella of the lumbodorsal fascia. Its fibres pass upward to be inserted on the lower border of the

twelfth rib and the transverse processes of the upper two or three lumbar vertebrae.

Clean the external iliac vessels. The external iliac artery arises opposite the lumbosacral articulation as one of the terminal branches of the common iliac, and runs forward on the pelvic brim, at the medial border of the psoas major, to pass behind the medial part of the inguinal ligament. Beyond this point it is continued into the thigh as the femoral artery. It is crossed superiorly near the inguinal ligament by the ductus deferens (or the round ligament of the uterus). Just before it passes behind the inguinal ligament it gives rise to its only branches, the inferior epigastric and deep circumflex iliac arteries. The full course of the inferior epigastric has already been traced. The deep circumflex iliac artery arises from the lateral side of the external iliac, and runs laterally and upward along the line of junction of the iliac fascia with the inguinal ligament. At the anterior superior iliac spine it pierces the transversus muscle, to run posteriorly along the iliac crest between the transversus and the internal oblique, where it has already been exposed. The external iliac vein begins behind the inguinal ligament as a continuation of the femoral vein. From this point to its termination in the common iliac it lies just medial to the artery.

Below the iliac crest the postero-lateral portion of the abdominal wall is formed by the iliacus muscle. This is a broad flat muscle which fills the iliac fossa, from the bony surface of which it takes origin. Its fibres pass downward and medially behind the inguinal ligament to join the tendon of insertion of the psoas major. The iliacus is covered internally by a fairly dense fascial layer, the iliac fascia, which joins the inguinal ligament anteriorly. In removing this fascia to expose the muscle, do not injure the lateral femoral cutaneous nerve. This nerve will be found emerging from behind the psoas and running laterally across the iliacus. It enters the thigh by passing behind the inguinal ligament just medial to the anterior superior spine of the ilium. Passing behind the inguinal ligament immediately lateral to the psoas, in the groove between the psoas and the iliacus, identify the femoral nerve. This large nerve emerges from behind the psoas and passes into the thigh behind the inguinal ligament. (Fig. 48.)

Clean and study the lumbar portions of the sympathetic trunks. Each sympathetic trunk enters the abdomen by passing through or behind the corresponding crus of the diaphragm. It then runs downward on the

anterior surfaces of the lumbar vertebrae just medial to the psoas major. Each trunk usually exhibits four lumbar ganglia, which receive rami communicantes from the first four lumbar nerves. From each trunk branches pass forward to the aortic plexus. Inferiorly the sympathetic trunks pass downward over the sacral promontory into the pelvis. Observe that the right trunk lies behind the vena cava inferior and the left one is crossed anteriorly by the left common iliac vessels.

Draw the aorta forward and display the four pairs of lumbar arteries arising from its posterior aspect. These pass backward and laterally around the bodies of the first four lumbar vertebrae, external to the sympathetic trunks, and behind the psoas, which they supply. In their further course they are usually behind the quadratus lumborum.

Section the aorta just below the origin of the coeliac artery and again just above its bifurcation. Section the lumbar arteries at their origin from the intervening segment of aorta and remove the latter. Dissecting in the areolar tissue behind the aorta, attempt to display the cisterna chyli. This is the lower expanded portion of the thoracic duct. It lies in front of the body of the second lumbar vertebra and receives the lymphatic vessels from all parts of the body below the diaphragm. From the cisterna the thoracic duct ascends through the hiatus aorticus into the posterior mediastinum of the thorax.

Portions of the ilioinguinal, iliohypogastric, lateral femoral cutaneous, genitofemoral, and femoral nerves have already been displayed, in relation to the muscles of the posterior abdominal wall. These nerves are all derived from the lumbar plexus. The distribution of the iliohypogastric and ilioinguinal nerves was followed in the dissection of the anterior abdominal wall. If the genitofemoral nerve is now traced downward on the psoas, it will be found to terminate by dividing into two branches, the external spermatic and the lumboinguinal. The external spermatic nerve has already been traced into the abdominal inguinal ring as the nerve of supply of the cremaster muscle. The lumboinguinal nerve crosses the iliacus to pass behind the inguinal ligament into the thigh.

The lumbar plexus itself lies deeply within the substance of the psoas major muscle. For its display it will be necessary carefully to cut away the psoas major. A convenient method of starting this dissection is to follow the genitofemoral nerve upward and posteriorly into the muscle. When the

twelfth rib and the transverse processes of the upper two or three lumbar vertebrae.

Clean the external iliac vessels. The external iliac artery arises opposite the lumbosacral articulation as one of the terminal branches of the common iliac, and runs forward on the pelvic brim, at the medial border of the psoas major, to pass behind the medial part of the inguinal ligament. Beyond this point it is continued into the thigh as the femoral artery. It is crossed superiorly near the inguinal ligament by the ductus deferens (or the round ligament of the uterus). Just before it passes behind the inguinal ligament it gives rise to its only branches, the *inferior epigastric* and *deep circumflex iliac arteries*. The full course of the inferior epigastric has already been traced. The deep circumflex iliac artery arises from the lateral side of the external iliac, and runs laterally and upward along the line of junction of the iliac fascia with the inguinal ligament. At the anterior superior iliac spine it pierces the transversus muscle, to run posteriorly along the iliac crest between the transversus and the internal oblique, where it has already been exposed. The external iliac vein begins behind the inguinal ligament as a continuation of the femoral vein. From this point to its termination in the common iliac it lies just medial to the artery.

Below the iliac crest the postero-lateral portion of the abdominal wall is formed by the iliacus muscle. This is a broad flat muscle which fills the iliac fossa, from the bony surface of which it takes origin. Its fibres pass downward and medially behind the inguinal ligament to join the tendon of insertion of the psoas major. The iliacus is covered internally by a fairly dense fascial layer, the *iliac fascia*, which joins the inguinal ligament anteriorly. In removing this fascia to expose the muscle, do not injure the lateral femoral cutaneous nerve. This nerve will be found emerging from behind the psoas and running laterally across the iliacus. It enters the thigh by passing behind the inguinal ligament just medial to the anterior superior spine of the ilium. Passing behind the inguinal ligament immediately lateral to the psoas, in the groove between the psoas and the iliacus, identify the femoral nerve. This large nerve emerges from behind the psoas and passes into the thigh behind the inguinal ligament. (Fig. 48.)

Clean and study the lumbar portions of the *sympathetic trunks*. Each sympathetic trunk enters the abdomen by passing through or behind the corresponding crus of the diaphragm. It then runs downward on the

necessary to tie the body in the so-called lithotomy position, with the thighs widely spread and the inferior pelvic aperture facing upward. Throughout the dissection it should be borne in mind that with the body in this position structures which are anatomically superior or inferior will appear to the dissector in exactly the reverse positions.

A knowledge of the pelvic skeleton is essential for a proper dissection of the perineum. Before starting the dissection study an articulated bony

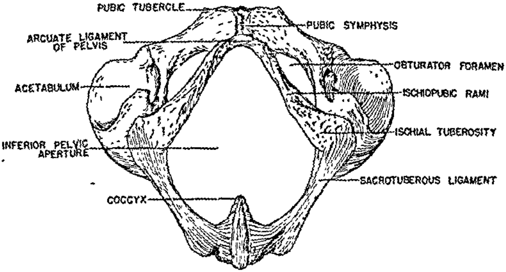

FIG. 49—Inferior view of the pelvic skeleton, with the ligaments in place.

pelvis, preferably one with the ligaments still in place. Observe that the most anterior point of the perineum is represented in the skeleton by the lower end of the pubic symphysis; this bony surface is covered by the arcuate ligament of the pelvis. Posteriorly the perineum is limited by the coccyx. Its widest lateral extent is about midway between the symphysis and the coccyx and is limited on either side by the tuberosity of the ischium. Its anterolateral boundary is formed on either side by the inferior rami of the pubis and the ischium. Posterolaterally the perineum is bounded by the sacrotuberous ligament which stretches from the lower end of the sacrum and the coccyx to the ischial tuberosity. As the dissection proceeds it will be found that this ligament is covered externally by the lower part of the gluteus maximus muscle, so that the lower border of this muscle may be regarded as forming on either side the posterolateral boundary of the perineum. The ischio-pubic rami, the ischial tuberosity, and the coccyx may be palpated from the surface, and should be identified before the skin is reflected.

plexus is exposed it will be seen to be derived from the anterior rami of the first four lumbar nerves. The branches which arise from the plexus are the iliohypogastric, ilioinguinal, femoral, genitofemoral, lateral femoral cutaneous, and obturator nerves. Some portion of each of these nerves, with the exception of the obturator, has already been seen. The obturator nerve arises within the psoas by three roots, which are derived from the anterior rami of the second, third, and fourth lumbar nerves. It emerges from the medial border of the psoas and enters the pelvis minor by passing downward behind the common iliac vessels. (Fig. 48.)

The femoral nerve is the largest branch of the lumbar plexus. It also is derived from the second, third, and fourth lumbar nerves. It emerges from the lateral border of the psoas, from which point its further abdominal course has already been seen; it gives twigs of supply to the iliacus muscle.

The genitofemoral nerve has two roots, which are derived from the first and second lumbar nerves. The iliohypogastric and ilioinguinal nerves are both derived from the first lumbar nerve, though they often receive also a communication from the last thoracic. Observe that as they emerge from the lateral border of the psoas to cross the quadratus lumborum these two nerves are in relation with the posterior surface of the kidney. The lateral femoral cutaneous nerve is derived from the second and third lumbars; it is sometimes represented by two smaller nerves, which cross the iliacus at some distance from each other.

In addition to these branches, the four roots of the lumbar plexus give twigs of supply directly to the psoas and quadratus muscles. From the fourth lumbar nerve a large branch descends to join the sacral plexus. A small branch known as the accessory obturator nerve is sometimes found to arise from the third and fourth lumbar nerves; it descends along the medial border of the psoas and enters the thigh by crossing the pecten of the pubis.

THE PERINEUM

The perineum is a diamond-shaped area at the lower end of the trunk, between the thighs. It corresponds to the inferior pelvic aperture, and as a distinct region of the body it is separated from the pelvic portion of the abdominal cavity by the pelvic diaphragm. In the erect posture the surface area of the perineum is reduced to a narrow groove running forward from the coccyx to the pubis, between the thighs. For its dissection it is therefore

the ischio-pubic rami of the two sides. It is composed of two layers of fascia, superior and inferior, separated from each other by a narrow interval in which the deep transverse perineal muscle and the sphincter urethrae muscle are contained. Laterally each layer of fascia is firmly attached to the ischio-pubic rami. Anteriorly, the diaphragm does not quite reach the lower end of the pubic symphysis but presents a short free margin, known as the transverse ligament of the pelvis, along which its two fascial layers are joined. Posteriorly it presents a much longer free margin, along which also its two layers are joined, and which stretches across between the two ischial tuberosities.

Colles fascia ends laterally on either side by attaching to the margins of the ischio-pubic rami. Posteriorly it does not extend into the anal triangle, but ends by attaching to the posterior free margin of the urogenital diaphragm. Anteriorly, however, it is continuous through the dartos tunic of the scrotum, and around the sides of the penis and scrotum, with the fascia of Scarpa on the lower part of the anterior abdominal wall. The space intervening between Colles fascia and the inferior fascial layer of the urogenital diaphragm is known as the superficial pouch of the perineum, and contains the structures constituting the root of the penis. When the attachments of the fascia of Colles have been investigated, it should be left in place for the present, and attention should be directed to the anal triangle.

Identify the central point of the perineum. This is a tendinous septum in the midline of the body a short distance in front of the anus. Then clean the external sphincter ani muscle. This is a thick ring of muscle fibres, running backward from the central point to the tip of the coccyx, and encircling the anus. As it is cleaned small branches of the inferior haemorrhoidal nerve and artery will be found emerging from the fat on either side to enter the muscle. (Fig. 50.)

The further dissection of the anal triangle consists principally in the display of the boundaries and contents of the two ischiorectal fossae. Each ischiorectal fossa is a space lying lateral to the lower end of the anal canal. The supero-medial boundary of each is formed by the inferior surface of the pelvic diaphragm, which separates the fossa from the pelvic cavity. Anteriorly it is bounded by the blending of Colles fascia with the posterior border of the urogenital diaphragm. The lateral wall of each ischiorectal fossa is formed by a layer of fascia known as the obturator fascia, which

The perineum is arbitrarily subdivided by an imaginary transverse line running between the anterior portions of the two ischial tuberosities into an anterior urogenital triangle, and a posterior anal triangle. At the anal orifice, which appears in the anal triangle, the skin of the perineum becomes continuous with the mucous membrane of the anal canal.

Dissection of the Male Perineum

Distend the anal canal slightly *with cheesecloth and stitch the lips of* the anal orifice together. Then make two incisions through the skin of the perineum. (1) A median longitudinal incision, running from the upper posterior part of the skin of the scrotum backward to a point about an inch above the tip of the coccyx. This incision must encircle the anal orifice. (2) A transverse incision running from a point about an inch lateral to the ischial tuberosity on one side across in front of the anus to a similar point on the other side. By this means four triangular flaps of skin will be marked out. The two anterior flaps should be reflected forward and laterally; the two posterior flaps backward and laterally.

The reflection of skin will expose the superficial fascia of the perineum. In the anal triangle this layer differs from the same layer in other parts of the body only in its extreme thickness. In the urogenital triangle it is thinner and shows a differentiation into two parts, an outer fatty layer, and a deeper membranous layer. This deeper membranous layer is known as the fascia of Colles; it should now be demonstrated. To do this, cut down through the outer layer of fatty superficial fascia along the midline of the urogenital triangle until the membranous is reached, and reflect it to either side, attempting to keep Colles fascia intact. This must be done with care to avoid injury to the superficial perineal nerves, which lie just internal to Colles fascia. As the superficial fatty layer is reflected, it will be found to be continuous laterally over the ischio-pubic rami with the same layer of fascia on the medial aspect of the thigh, and posteriorly with the superficial fascia of the anal triangle. Now examine the extent and attachments of the fascia of Colles.

Fully to understand Colles fascia it is necessary to have some knowledge of the urogenital diaphragm, a structure which will not actually be seen until somewhat later in the dissection. The urogenital diaphragm is a membranous and muscular structure which stretches across the gap between

the inferior surface of the urogenital diaphragm by detaching the crura from the diaphragm and from the ischiopubic rami. As the anterior portions of the crura are being detached find the dorsal nerve of the penis and the internal pudendal artery, which here pierce the inferior fascial layer of the urogenital diaphragm under cover of the crura. Just as it emerges from the urogenital diaphragm the internal pudendal artery terminates by dividing into the deep artery of the penis, which enters the crus, and the dorsal

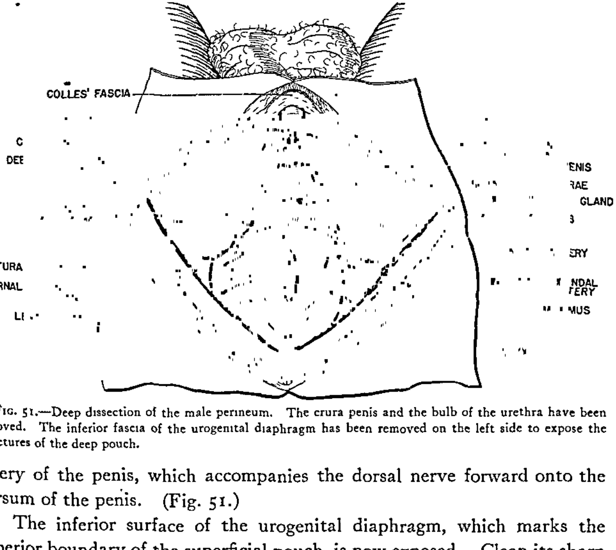

FIG. 51.—Deep dissection of the male perineum. The crura penis and the bulb of the urethra have been removed. The inferior fascia of the urogenital diaphragm has been removed on the left side to expose the structures of the deep pouch.

artery of the penis, which accompanies the dorsal nerve forward onto the dorsum of the penis. (Fig. 51.)

The inferior surface of the urogenital diaphragm, which marks the superior boundary of the superficial pouch, is now exposed. Clean its sharp anterior border, the transverse ligament of the pelvis. Observe that this lies just behind the arcuate ligament, which covers the lower border of the pubic symphysis, and that the deep dorsal vein of the penis enters the pelvic cavity by passing through the narrow interval between the transverse and arcuate ligaments.

Now reflect the inferior layer of fascia of the urogenital diaphragm to open the so-called deep pouch of the perineum. This is the space enclosed

small paired muscle, variable in size and degree of development, and consequently often difficult to demonstrate. It arises from the inner surface of the anterior part of the ischial tuberosity and is inserted at the central point of the perineum, where it blends somewhat with the external sphincter ani and the bulbo-cavernosus.

The ischio-cavernosus and bulbo-cavernosus are thin sheets of muscle which cover the external surfaces of the structures forming the root of the penis. These structures are the bulb of the urethra and the two crura of the penis.

The bulb of the urethra lies in the median plane. It is attached above to the under surface of the inferior fascial layer of the urogenital diaphragm. It is covered externally by the bulbo-cavernosus muscle. Anteriorly it narrows to become continuous with the corpus cavernosum urethrae. Each crus penis is attached to the corresponding ischio-pubic rami and the inferior surface of the lateral parts of the urogenital diaphragm. They run forward and medially and unite in front of the lower part of the pubic symphysis to form the corpus cavernosum penis. Each is covered by an ischio-cavernosus muscle.

The bulbo-cavernosus arises from the central point of the perineum and from a median raphe running forward on the under surface of the bulb. From this origin its fibres diverge to surround the bulb and be inserted into the fascia of the urogenital diaphragm and the dorsal surface of the corpus cavernosum urethrae. Some of its most anterior fibres reach the dorsum of the corpus cavernosum penis. Each ischiocavernosus arises from the inner aspect of the ramus of the ischium and is inserted into the lateral aspect of the anterior part of the crus.

Dissect between the bulb and the crus, and expose the lower surface of the urogenital diaphragm. Attempt to separate the bulb from the diaphragm and observe that it is firmly attached superiorly to the diaphragm at a point in the midline about half an inch in front of its posterior end. At this point the urethra pierces the urogenital diaphragm to enter the bulb. Attempt to display the small artery to the bulb, which pierces the diaphragm on either side of the urethral orifice, to enter the bulb. Draw the bulb forward, cut through the urethra at the point where it enters the bulb, and reflect the bulb and corpus cavernosum urethrae forward, to expose the lower surface of the urogenital diaphragm. Complete the display of

Anteriorly they converge and each divides into two folds. The lower fold from each labium minus is attached to the under surface of the clitoris to form the frenulum clitoridis. The upper fold from each labium minus unites with the fold from the other side above the clitoris to form the praeputium clitoridis. Between the frenulum and the praeputium the glans clitoridis will be seen. The region between the labia minora and behind the clitoris is known as the vestibule. The vaginal orifice will be seen opening into the posterior part of the vestibule. It may or may not be partly guarded by a fold of mucous membrane, the hymen. The urethral orifice is a small slit-like opening in the wall of the vestibule slightly anterior to the vaginal orifice. On either side of the vaginal orifice the minute opening of the duct of the greater vestibular gland may be seen.

Distend the anal canal and the vagina slightly with cheese-cloth and stitch together the lips of the anal orifice and the margins of the labia minora. Then make two incisions through the skin: (1) a median longitudinal incision from the mons pubis backward to a point about an inch above the tip of the coccyx; this incision must bifurcate to encircle the labia minora, and again to encircle the anus; (2) a transverse incision passing in front of the anus from a point about an inch lateral to the ischial tuberosity on one side to a similar point on the other side. Four flaps of skin will thus be marked out; the two anterior ones should be reflected forward and laterally, the two posterior ones backward and laterally.

The superficial fascia of the female urogenital triangle shows the same differentiation into deep and superficial layers as does that of the male. The fascia of Colles is, however, divided into two parts by the presence of the urogenital fissure. Its lateral and posterior attachments are the same as in the male, and it should be cleaned, as in the male, by the removal of the fatty superficial layer. Observe that in the labia majora and the mons pubis this superficial fatty layer is very thick. Later stages in the dissection will be facilitated if this layer is all removed now, leaving the fascia of Colles clean.

The dissection of the anal triangle in the female is precisely the same as in the male, and the same structures will be exposed as in the male, with the exception that the place of the dorsal nerve of the penis is taken by the dorsal nerve of the clitoris, which is considerably smaller than the corresponding nerve in the male. (Pages 193–195.)

between the two fascial layers of the urogenital diaphragm itself, and contains the deep transverse perineal muscle, the sphincter urethrae muscle, the membranous urethra, portions of the dorsal nerve of the penis and the internal pudendal artery, and the bulbo-urethral glands.

The sphincter urethrae is a thin muscle which stretches across between the ischio-pubic rami of the two sides and encircles the membranous urethra. It is continuous posteriorly with the deep transverse perineal muscle, which also stretches across between the ischio-pubic rami.

The second or membranous portion of the male urethra is short and traverses the urogenital diaphragm from above downward. It was cut, in the present dissection, at the point at which it joined the third or cavernous portion of the urethra. The bulbo-urethral glands are embedded in the deep transverse perineal muscle, a short distance behind the urethra. Their fine ducts pierce the inferior fascia of the diaphragm to enter the bulb and join the third part of the urethra.

The dorsal nerve of the penis and the internal pudendal artery were previously seen to enter the urogenital diaphragm at the anterior end of Alcock's canal. They may now be traced forward along the lateral margin of the deep pouch to the point at which they were found to leave it by piercing the inferior fascia. Observe that while in the deep pouch the internal pudendal artery gives rise to the artery to the bulb, which pierces the inferior fascia independently, to enter the bulb as already noted.

The Female Perineum

The urogenital triangle of the female perineum includes the urethral orifice and the external genital organs, which should be studied before any dissection is done.

The mons pubis is an elevation of the skin in front of the pubic symphysis which is caused by the presence of a thick layer of adipose tissue. Extending downward and backward from the mons pubis on either side are the labia majora, folds of skin and fascia, which diminish in size posteriorly and meet a short distance in front of the anus. Between the two labia majora is the urogenital fissure, which contains the urethral and vaginal orifices. Overlapped by the labia majora are two much thinner integumental folds, the labia minora, which lie on either side of the vaginal orifice.

structures occupying the extra-peritoneal space; third, the study of the visceral pelvic fascia and the pelvic viscera which it encloses, during which the pelvis will be split into two halves; and finally the removal of the viscera and study of the muscles of the pelvic diaphragm and the pelvic wall.

The male and female pelvis should be compared at each stage of the dissection.

Male Pelvis

Any peritoneum which still remains in place above the pelvic brim should be removed, but the peritoneum within the pelvis minor should be left for the present undisturbed. It is well, also, to remove whatever portions of the anterior abdominal wall may be left above the inguinal and lacunar ligaments, which should be allowed to remain in situ. The sigmoid colon and mesocolon should be cut at the place where they cross the brim of the pelvis, and any portions of these structures remaining above the pelvic brim removed. Next identify the various structures which enter or leave the pelvis by crossing the pelvic brim external to the peritoneum. These are as follows.

Running upward toward the umbilicus from behind the pubic symphysis will be found the urachus or middle umbilical ligament. Somewhat lateral to this on either side, also running toward the umbilicus, is the lateral umbilical ligament, a cordlike structure representing the umbilical artery of the foetus. Still more laterally the ductus deferens descends into the pelvis, having first crossed the external iliac artery and vein shortly before their passage behind the inguinal ligament. The ureter crosses the pelvic brim on each side at about the point where the common iliac arteries terminate. Here also the large hypogastric artery and vein descend into the pelvis. Running downward in front of the sacrum the middle sacral vessels should be identified, and slightly to the left of these the superior haemorrhoidal vessels cross in front of the left common iliac vessels to run downward into the pelvis minor. The obturator artery will occasionally be found running downward across the brim of the pelvis slightly anterior to the ductus deferens. In such cases it is a branch of the inferior epigastric or of the external iliac artery. In most cases, however, the obturator artery does not cross the brim of the pelvis, but arises within the cavity of the pelvis minor as a branch of the hypogastric.

THE PELVIS MINOR

The cavity of the pelvis minor is the lowest and most posterior portion of the general abdominal cavity. It communicates freely with the abdomen proper at the pelvic brim, which is bounded by the terminal lines of the two coxal bones and the sacrum. The pelvic cavity is bounded anteriorly and laterally by the internal surfaces of the coxal bones, covered by the obturator internus muscles and the obturator fascia and posteriorly by the anterior surface of the sacrum, which is also covered internally by a prolongation of the obturator fascia. Inferiorly the pelvic cavity is separated from the perineum by the pelvic diaphragm. The pelvic diaphragm is composed of two paired muscles, the levator ani and the coccygeus, covered on both their superior and their inferior surfaces by a layer of fascia. The fascia covering the inferior surface of the pelvic diaphragm is the so-called anal fascia, and has already been seen in the dissection of the perineum, where it forms the medial wall of the ischiorectal fossa. The superior fascial layer of the pelvic diaphragm is known as the visceral layer of the endopelvic fascia; it not only covers the superior surfaces of the muscles of the pelvic diaphragm, but also splits to form fascial sheaths in which the pelvic viscera are more or less completely enclosed. The fascia covering the internal surfaces of the obturator internus muscle (obturator fascia), and its extension across the front of the sacrum, are known as the parietal pelvic fascia. The parietal fascia, from which in large part the muscles and fascia of the pelvic diaphragm arise, forms not only the lateral wall of the cavity of the pelvis minor, but extends into the perineum as well, where it has been seen to form the lateral wall of the isochiorectal fossa.

The peritoneum extends below the pelvic brim, but does not reach so far as the pelvic diaphragm. Consequently a considerable portion of the pelvic cavity is extra-peritoneal. The principal contents of the pelvic portion of the peritoneal cavity are coils of the small intestine, which have already been removed, and the sigmoid colon. In the female, however, the uterus is entirely clothed with peritoneum and projects upward and forward into the pelvic peritoneal cavity.

The dissection of the pelvis can be most satisfactorily prosecuted in four stages: first, the observation and study of the disposition of the pelvic peritoneum; second, the removal of the peritoneum, and study of the

exposing a space known as the cave of Retzius, which intervenes between the pelvic wall and the inferolateral surfaces of the bladder. This is a potential rather than an actual space, since it is narrow, and filled with fatty areolar tissue. Its importance lies in the fact that an effusion of fluid into it, as from a rupture of the bladder, may readily spread laterally as far as the hypogastric arteries, and upward into the extra-peritoneal space at the sides of the pelvic and abdominal cavities.

As the bladder is turned upward and backward it will be seen that while its infero-lateral surfaces can be readily detached from the pelvic wall, its neck is firmly attached to the pelvic floor. The neck of the bladder is the region to which the two infero-lateral surfaces and the posterior surface converge. It lies immediately above the prostate gland, which is enclosed in a heavy sheath of the visceral fascia. When the fatty areolar tissue has all been removed from the cave of Retzius, two white fascial bands will be seen running forward from the neck of the bladder to be attached to the inner surface of the body of the pubis on either side of the pubic symphysis. These are the anterior true ligaments of the bladder or pubo-prostatic (pubo-vesical) ligaments, and represent thickenings of the visceral layer of the endopelvic fascia.

Now attempt to define the line along which the pelvic diaphragm springs from the pelvic wall. This dissection must be done on the left side. Detach the left ureter, the left ductus deferens, and the superior haemorrhoidal vessels from where they have previously been stitched to the left common or external iliac artery and turn them over to the right side of the pelvis. Push the peritoneum of the left pararectal fossa over to the right, open the left cave of Retzius widely by displacing the bladder toward the right, and remove all the fatty areolar tissue which may remain. The object of this dissection is to clean the upper surface of the lateral part of the pelvic diaphragm and the parietal fascia on the left side. This should be done without regard to the visceral branches of the hypogastric artery or to any veins obscuring the dissection, which should be removed.

With the aid of reference to a bony pelvis, locate by touch the pelvic surface of the spine of the ischium. If the fascia has been carefully cleaned a tendinous fascial band will be seen running from the spine in a curve upward and forward to the lower border of the obturator canal. Anterior to the obturator canal the same band turns downward and forward across the

Clean first the ductus deferens. It lies on the side wall of the pelvis immediately external to the peritoneum, crossing in turn the umbilical artery, the obturator nerve and vessels, and the ureter. Here it turns downward behind the bladder and enters the visceral pelvic fascia; its further course will be followed later.

Follow the lateral umbilical ligament backward across the pelvic wall, and observe that it springs from the hypogastric artery, of which it was in fact the original direct continuation. Two or three small vessels will be found to arise from it and pass to the bladder. These are the superior vesical arteries. Distal to the origin of the last of these the lateral umbilical ligament is a solid cord. Proximal to that point it is a patent vessel of small calibre, the umbilical artery.

The obturator nerve has already been seen to arise from the lumbar plexus above the pelvic brim, which it crosses external to the common iliac vessels. It will be found emerging from the medial side of the psoas major muscle behind the hypogastric artery and running forward across the pelvic wall to enter the obturator canal. Entering the obturator canal just below the nerve is the obturator artery, and below it the obturator vein. The parietal pelvic fascia is prolonged into the thigh through the obturator canal to form a sheath for the obturator nerve and vessels. Trace the obturator artery back to the hypogastric, of which it is usually a branch. It may arise from the hypogastric by a common stem with the umbilical or with some other branch or branches of the hypogastric.

Clean the pelvic portion of the ureter. It runs downward and forward in front of the hypogastric artery to the posterolateral angle of the bladder. Here, just below the point at which it is crossed anteriorly by the ductus deferens, it also enters the visceral pelvis fascia.

Attention should next be directed to the bladder, whose outline will have become apparent with the removal of the peritoneum. The bladder presents a superior surface, which is completely covered with peritoneum, a posterior surface, covered only on its upper part, and two inferolateral surfaces, which are devoid of peritoneum and in relation to the pelvic wall and pelvic diaphragm. The urachus or middle umbilical ligament runs upward from the apex of the bladder, at which the superior and the two infero-lateral surfaces meet. If the apex is pulled upward and backward the infero-lateral surfaces may easily be detached from the pelvic wall,

prostate and the infero-lateral surfaces of the bladder, and is known as the vesical fascia.

The pelvis is now to be split into two parts for the further study of the viscera. The pelvic skeleton will be separated into approximately equal halves, but all of the viscera, the entire right half of the pelvic diaphragm, and most of the left half, are to remain with the right half of the skeleton.

Cut through the left common iliac artery near its origin and the left common iliac vein near its termination. Disarticulate the fifth from the fourth lumbar vertebra by cutting through the articular disc and cutting the capsular ligaments of the articular processes; cut through what remains of the posterior abdominal wall at this level. Cut through the center of the pubic symphysis. Then carry the knife from front to back in a roughly semicircular cut through the entire thickness of the pelvic diaphragm close to where it springs from the pelvic wall on the left side. Cut through the urogenital diaphragm near its attachment to the left ischio-pubic rami. Then, pushing the viscera well over to the right so that they will not be injured, saw through the fifth lumbar vertebra, sacrum, and coccyx in a sagittal plane very slightly to the left of the midline, and separate the pelvis completely into two parts. The further dissection is to be carried out on the right part. (Fig. 54.)

Clean *the outer surface of the rectum and observe that there is a* considerable portion of it which is entirely devoid of peritoneum, since it lies below the lowest part of the rectovesical peritoneal pouch. The lowest part of the rectum turns downward and backward almost at right angles from the upper part which runs downward and forward, and passes through the pelvic diaphragm to reach the anus. This is the anal canal (pars analis recti). Trace the superior haemorrhoidal artery downward along the posterior surface of the rectum. It divides into two main branches, one passing to each side of the rectum, to anastomose with the right and left middle haemorrhoidal arteries. These are branches of the hypogastric. The cut end of the left middle haemorrhoidal artery should be sought where it reaches the left side of the upper part of the anal canal. Remove any peritoneum which may still be left.

Clean the prostrate from the left side. It rests upon the upper surface of the middle of the urogenital diaphragm. The two levator ani muscles

internal surface of the pubic bone as far as the anterior end of the anterior true ligament of the bladder. This band is the arcus tendineus, or tendinous arch, and marks the line along which the *pelvic diaphragm springs from the pelvic wall.* From the ischial spine to the obturator canal the pelvic diaphragm (i.e., the levator ani muscle and the visceral pelvic fascia which covers it superiorly) *arises from the obturator fascia; anterior to the obturator canal, the diaphragm arises directly from the internal surface of the pubic bone.*

It has been said that the obturator fascia, which forms the lateral boundary of the pelvic cavity, is the same layer which extends down into the perineum to form the lateral wall of the ischiorectal fossa. It will now be apparent that the obturator fascia is seen within the pelvis minor only posterior to the obturator canal. Here the fibres of the obturator internus muscle can usually be seen through the fascia, or a portion of the fascia may be removed to expose them. It will also be apparent that the pelvic diaphragm does not stretch horizontally across the pelvis, but runs downward as well as medially from either side, so that the diaphragm as a whole has roughly the shape of an inverted dome. This should explain the apparent contradiction that the inferior surface of the pelvic diaphragm forms the medial wall of the ischiorectal fossa. If now one hand is introduced through the perineum into the left ischiorectal fossa and the other hand into the pelvis from above, the entire thickness of the pelvic diaphragm may be felt between the two hands.

The visceral fascia *forming the uppermost layer of this lateral portion of* the pelvic diaphragm is a single layer, in direct relation to the upper surface of the levator ani muscle, which can usually be seen through it. This portion *of the visceral fascia is known as the rectal fascia.* Passing medially the rectal fascia extends across behind the rectum, still in close relation to the upper surface of the levator ani, to become directly continuous with the same fascia on the other side of the pelvis. As it approaches the midline anterior to the rectum the visceral fascia is prolonged upward over the posterior surface of the prostate gland, and still higher encloses the seminal vesicles, which lie behind the posterior surface of the bladder. This portion of the visceral fascia is known as the rectovesical fascia. Still more anteriorly the visceral fascia is prolonged upward over the anterior surface of the

The hypogastric artery has already been seen to arise from the common iliac and run down into the pelvis, crossing the pelvic brim opposite the sacro-iliac articulation, where it lies medial to the external iliac vein and usually anterior to the hypogastric vein. The hypogastric artery gives rise to visceral and parietal branches. The visceral branches are the umbilical, inferior vesical and middle haemorrhoidal; the parietal branches are the iliolumbar, lateral sacral, obturator, internal pudendal, and superior and inferior gluteal. These branches are constant in their occurrence, but the manner in which they arise from the main trunk is subject to great variation. The umbilical artery, which has already been seen, may be regarded as the direct continuation of the main trunk. The superior gluteal, inferior gluteal, and internal pudendal arteries always arise in that order from above downward, but any two or all three may arise by a common stem; the inferior gluteal and internal pudendal very frequently do so. All other branches may arise directly from the hypogastric or indirectly by any combination of common stems. The iliolumbar and lateral sacral very often arise in common with the superior gluteal. Identify the various branches and trace them so far as their course lies within the pelvis. (Fig. 54.)

The iliolumbar artery runs upward and laterally to cross the pelvic brim external to the common iliac artery and vein, where it divides into iliac and lumbar branches. The iliac branch runs laterally behind the psoas major to enter the deep surface of the iliacus; the lumbar branch runs upward behind the psoas, supplying it and the quadratus lumborum.

The lateral sacral runs downward and medially over the anterior surface of the sacrum. There are frequently two lateral sacrals. The superior gluteal leaves the pelvis through the upper part of the greater sciatic foramen. The inferior gluteal and internal pudendal have a longer course in the pelvis, which they leave through the lower part of the greater sciatic foramen, just above the spine of the ischium. The obturator has already been traced.

The inferior vesical and middle haemorrhoidal vessels, which often arise in common, run medially through the fatty areolar tissue above the pelvic diaphragm. The former supplies the lower part of the bladder, and the prostate; the latter reaches the side wall of the rectum, along which it sends branches to anastomose with the superior and inferior haemorrhoidals.

do not meet in the midline anteriorly, and the gap in the pelvic diaphragm thus left between their free margins is closed below by the urogenital diaphragm. The prostate is enclosed in a strong sheath derived from the visceral fascia. Posteriorly this fascia can not easily be separated from the gland. Anteriorly and at the sides the pudendal plexus of veins will be found to intervene between the gland and its fascial covering. The dorsal vein of the penis enters beneath the pubic symphysis and above the anterior border of the urogenital diaphragm, to join this plexus. Above the prostate clean the left seminal vesicle. This also is enclosed in a tough fascial sheath

Fig. 54.—The right half of the male pelvis, seen from the left side.

which must be removed to expose the contour of the vesicle. It rests against the posterior surface of the bladder. Along its medial border will be found the terminal part of the ductus deferens also enclosed in the fascia. Between the two ductus deferentes the posterior surface of the bladder rests directly against the rectum.

For a detailed study of the structure and relations of the bladder, prostate and seminal vesicles, these organs should be removed from the pelvis, but before this is done, the pelvic blood vessels should be studied. In this study particular attention should be paid to the hypogastric artery and its branches. The veins of the pelvis are numerous and often plexiform in character and drain into the hypogastric vein. If they obscure the dissection of the arteries they should simply be cut away and discarded.

ureter runs for some distance within the wall of the bladder before opening into its interior.

Return to the posterior aspect of the bladder and attempt to demonstrate by dissection that each seminal vesicle is in reality a single long tube which is folded backward and forward on itself so that it presents a lobulated appearance. At its lower medial angle, immediately above the prostate, this tube narrows to form the excretory duct of the seminal vesical.

The ductus deferens, as it runs downward and medially along the medial border of the seminal vesicle, widens to form the ampulla of the ductus deferens. This terminates below by joining the excretory duct of the seminal vesicle, to form the ejaculatory duct. The two ejaculatory ducts pass through the substance of the prostate gland to join the prostatic portion of the urethra.

The prostate gland occupies the interval between the anterior portions of the two levator ani muscles. Superiorly it rests against the bladder and inferiorly against the upper surface of the urogenital diaphragm. It is traversed by the first portion of the urethra. This should be opened from the front. To do this, make an incision through the inferior border of the bladder straight backward from the apex to the front of the urethral orifice and then carry the same incision downward through the anterior portion of the prostate. (Fig. 55.)

Observe the urethral crest. This is a median longitudinal ridge on the posterior wall of the prostatic urethra. It is most prominent at about its middle, where it enlarges to form the seminal hillock (colliculus seminalis). At the summit of the hillock is the orifice of a small blind pouch, the prostatic utricle, which runs backward for a varying distance into the substance of the prostate. Just below and to either side of the orifice of the prostatic utricle are the small terminal orifices of the ejaculatory ducts. The ducts of the prostate gland itself open by a number of minute orifices on either side of the urethral crest; these may often be made apparent by squeezing the prostate.

The second or membranous portion of the urethra traverses the urogenital diaphragm. It may now be opened by removing whatever remains of the left side of the urogenital diaphragm. It is short, narrower than the prostatic portion, and its wall presents no features of particular interest.

The bladder, seminal vesicles, prostate, both ureters and both ductus deferentes should now be removed together from the pelvis. To do this pull the prostate upward and cut through the urethra where it leaves the lower part of the prostate to enter the urogenital diaphragm. The only thing now holding the viscera attached to the pelvic diaphragm is the visceral fascia and this should be cut along the borders of the viscera.

Clean the posterior surface of the bladder and observe its relations. It lies above the prostrate and is in direct contact with the anterior surfaces of the seminal vesicles, which separate its lower part from the rectum. The terminal portions of the deferent ducts cross the posterior surface of the bladder along the medial borders of the seminal vesicles. The uppermost portion of the posterior surface is covered by peritoneum and forms the

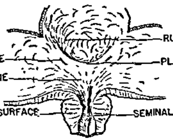

Fig. 55.—The interior of the male bladder and the prostatic portion of the urethra, opened from the front.

anterior boundary of the rectovesical pouch. The ureter joins the upper lateral angle of the bladder, where the posterior, superior, and inferolateral surfaces converge.

Open the bladder by a V-shaped incision in its superior surface. This incision should start just behind the apex and run backward and laterally on each side to a point slightly in front of the junction of the ureter with the bladder. The mucous membrane lining the bladder is thrown into irregular folds over most of its surface when the bladder is empty. In the area known as the trigone of the bladder (trigonum vesicae) however, it is always smooth. This is a triangular area corresponding to the lower portion of the posterior surface. It is bounded below by the internal urethral orifice, which is at the neck of the bladder and leads downward into the first or prostatic portion of the urethra, and above on either side by the ureteral orifices, which is slit-like in appearance. Observe the plica ureterica, a curved transverse ridge extending between the two ureteral orifices. Pass a probe through one of these orifices into the ureter and observe that the

THE FEMALE PELVIS

Leaving the peritoneum within the pelvic cavity intact, remove all the peritoneum above the brim of the pelvis, identifying at the same time the various structures which cross the brim external to the peritoneum. These are the urachus or middle umbilical ligament, the lateral umbilical ligament (umbilical artery), the round ligament of the uterus, the ureter, and the middle sacral, superior haemorrhoidal, hypogastric, and ovarian blood vessels. The urachus, the lateral umbilical ligament, the ureter, and the middle sacral, superior haemorrhoidal, and hypogastric vessels are the same as in the male. The ovarian vessels cross the pelvic brim a short distance anterior to the ureter. The round ligament occupies a position similar to that of the ductus deferens in the male, having first crossed the external iliac vessels near the inguinal ligament.

Now study the disposition of the peritoneum within the pelvic cavity. As in the male, the peritoneum covers the superior surface of the bladder, from which it is reflected upward on to the pelvic wall on each side as the lateral false ligament of the bladder, which forms the floor of a peritoneal fossa known as the paravesical fossa. This fossa is bounded posteriorly on each side, as in the male, by a peritoneal ridge caused by the ureter, but in the female it is subdivided into a large anterior and a small posterior portion by the broad ligament of the uterus, which should now be studied.

Diseased conditions of the female reproductive organs are very common in dissecting room subjects, and it is important to know in this dissection, whether or not one is dealing with a perfectly normal case. The following description applies to a normal, healthy, and moderately young individual and may not in all cases suit the subject under observation. (Fig. 56.)

At the posterior border of the bladder the peritoneum is reflected downward for a very short distance on to the posterior surface of the bladder and then up on to the front of the uterus, thus forming the floor of a shallow peritoneal fossa, the vesico-uterine pouch. The uterus is almost entirely clothed with peritoneum. Normally it is bent so that its anterior surface faces not only forward but downward, and overhangs the bladder. The broad ligament is a double fold of peritoneum which stretches on either side from the lateral border of the uterus to the side wall of the pelvis. Superiorly it presents a free border, in which the uterine tube is contained;

The third or cavernous portion of the urethra is much the longest of the three, traversing the whole length of the corpus cavernosum urethrae, to terminate at the glans penis. If the corpus cavernosum has been preserved this portion of the urethra should now be opened along its whole length, so that the three parts may be studied together. The bulbo-urethral glands open into the cavernous portion about half an inch from its beginning. Its terminal dilated portion is known as the fossa navicularis.

Return to the right half of the pelvis and clean the muscles of the pelvic diaphragm, by removing the remnants of the visceral fascia. These muscles are the levator ani and the coccygeus, of which the former is much the larger. The levator ani is a broad sheet of muscle whose line of origin is the same as that along which the visceral fascia arises. Anterior to the obturator canal it springs directly from the internal surface of the pubic bone; posterior to the obturator canal it springs from the internal surface of the obturator fascia along a curved line extending downward and backward to the spine of the ischium. Anteriorly the muscle presents a free margin which passes backward and medially around the side of the prostate to join, behind the prostate and in front of the rectum, the muscle of the opposite side. More posteriorly the levator ani is inserted into the side of the rectum and still more posteriorly it passes behind the rectum to join the muscle of the opposite side. The most posterior fibres are inserted upon the coccyx. Its nerve of supply, which is derived from the anterior ramus of the fourth sacral, should be sought running forward on its superior surface.

The coccygeus arises from the spine of the ischium and spreads out as it passes medially to be inserted on the coccyx and lower part of the sacrum. It is often more tendinous than muscular.

Observe that a portion of the parietal pelvic fascia covers the front of the sacrum above the coccygeus muscle. This is continuous on either side with the obturator fascia. The sacral nerves and the piriformis muscle lie external to it. The hypogastric artery and the beginning of its branches lie, as has been seen, internal to the parietal fascia. The parietal branches of the hypogastric pierce the parietal fascia as they leave the pelvis.

peritoneum becomes continuous with the mucous membrane lining the tube. Insert the point of the scissors into this opening and open the tube along its whole length, on the left side of the pelvis. Observe that it joins the upper lateral angle of the uterus. Cut through the peritoneum on the front of the broad ligament on the same side to expose the round ligament. This is a fibrous cord containing smooth muscle tissue, which is attached to the uterus just below its junction with the uterine tube. Cut through the

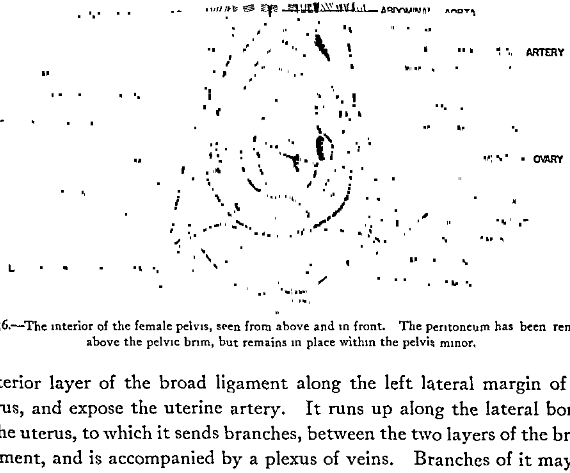

FIG. 56.—The interior of the female pelvis, seen from above and in front. The peritoneum has been removed above the pelvic brim, but remains in place within the pelvis minor.

posterior layer of the broad ligament along the left lateral margin of the uterus, and expose the uterine artery. It runs up along the lateral border of the uterus, to which it sends branches, between the two layers of the broad ligament, and is accompanied by a plexus of veins. Branches of it may be followed laterally through the broad ligament, toward the ovary, where they anastomose with the ovarian artery.

Now cut through the sigmoid colon where it joins the rectum in front of the third piece of the sacrum and remove it and the sigmoid mesocolon. Remove all of the peritoneum from the left side of the pelvis. The ovary, the ovarian vessels, and all that remains of the broad ligament, should be removed at the same time, but the ureter should be preserved. The peritoneum may be left on the uterus, but it should be detached from the superior surface of the bladder and the outline of that viscus defined. Now clean the structures which occupy the extra-peritoneal space on the left

at this border the two layers of peritoneum which compose the broad ligament are continuous with each other. At its medial border the broad ligament joins the lateral border of the uterus and here its two layers of peritoneum are continuous with the peritoneum covering the anterior and posterior surfaces of the uterus. Along its lateral and inferior borders the anterior and posterior peritoneal layers of the broad ligament are reflected anteriorly and posteriorly to become continuous with the peritoneum lining the pelvic wall and pelvic floor.

Projecting posteriorly from the lateral part of the broad ligament is a short double peritoneal fold, the mesovarium, which supports the ovary. The ovary is a small oval body, completely enclosed in peritoneum. The portion of the broad ligament above the mesovarium is known as the mesosalpinx; the portion below it is the mesometrium. As they run downward and medially below the pelvic brim, to reach the ovary, the ovarian vessels cause a peritoneal ridge in relation to the posterior surface of the lateral part of the broad ligament, known as the suspensory ligament of the ovary. Projecting from the anterior surface of the broad ligament another peritoneal fold will be seen; in this the round ligament is enclosed.

The female pelvic peritoneal cavity also presents, as does the male, middle or genital, and pararectal peritoneal fossae. The middle fossa is bounded anteriorly on either side by the ureteral ridge and posteriorly by the recto uterine-fold. The recto-uterine folds are similar to the sacrogenital folds of the male. They pass backward and laterally from the lower part of the posterior surface of the uterus toward the sacrum and may be wholly or partially obliterated by distention of the bladder or rectum. The two pararectal fossae communicate freely with each other in front of the rectum and behind the uterus, the whole forming the recto uterine peritoneal pouch. The lowest portion of the anterior wall of the recto uterine pouch is formed by the peritoneum, not on the uterus, but on the vagina, since the peritoneum is carried downward below the lower border of the uterus onto the uppermost portion of the posterior surface of the vagina, before being reflected backward and upward onto the front of the rectum.

At the upper lateral end of the broad ligament the uterine tube usually turns downward and backward so that its fimbriated end comes into close relation with the ovary. The open end of this tube is the only place at which the peritoneum is normally pierced. At the edges of this opening the

upward to form a fascial covering for the vagina, and still higher on to the wall of the uterus. More anteriorly it is prolonged upward onto the sides of the bladder. Running forward from the neck of the bladder to the internal surface of the pubis slightly lateral to the midline, it presents a thickening, the anterior pubo-vesical ligament, or anterior true ligament of the bladder.

The pelvis is now to be split into two parts. The pelvic skeleton is to be divided into two nearly equal halves, but all of the viscera, the entire right half of the pelvic diaphragm, and most of the left half, is to remain with the right part. The procedure for dividing the pelvis is the same as in the male. The further dissection is to be carried out on the right half.

Clean the rectum from the left side. It will now be apparent that there is a considerable portion of the rectum which is entirely devoid of peritoneum. The rectum is the same as in the male, except for the anterior relations of its lower portion, which is in direct contact with the posterior wall of the vagina.

The peritoneum on the right side of the pelvis is still intact. By carefully removing the posterior layer of the broad ligament, attempt to demonstrate the epoophoron and the proper ligament of the ovary. The former is a vestigial structure representing a part of the mesonephros of the embryo, which lies between the two layers of peritoneum of the mesosalpinx. The ovarian ligament is a band of smooth muscle and fibrous tissue which runs from the medial end of the ovary to the lateral border of the uterus, also lying between the two layers of peritoneum.

Now clean and study the hypogastric artery and its branches on the right side. To do this, most of the peritoneum and the extra-peritoneal areolar tissue must be removed. The arteries are the same in the female as in the male, with the addition of the uterine branch, whose course has already been seen on the left side. (Page 211.)

Open the bladder by a V-shaped incision in its superior surface, the apex of the V corresponding to the apex of the bladder, and study its interior. The interior of the female bladder does not differ from that of the male. Carry an incision backward from the apex along the inferior border to the internal urethral orifice and then downward through the whole length of the anterior wall of the urethra, thus opening the urethra. The female urethra is a short canal with a fibrous and muscular wall which lies immedi-

side, by removing the fatty areolar tissue in which they are embedded. The structures to be cleaned are the ureter, the umbilical artery (lateral umbilical ligament) and the obturator vessels and nerve. These structures are substantially the same as in the male. Observe, however, that the ureter crosses below the inferior border of the broad ligament to reach the upper lateral angle of the bladder. The uterine artery has already been seen running upward along the lateral border of the uterus; now follow it backward and laterally from the lower part of this border, through the extraperitoneal space to the hypogastric artery, of which it is a branch. Study the cave of Retzius, which is the same as in the male. (Page 207.)

The bladder presents the same surfaces as in the male; a superior surface, which as has been seen, is covered with peritoneum and is in relation to the anterior surface of the uterus and coils of the small intestine; two inferolateral surfaces, which, as in the male, are in relation to the pelvic diaphragm and form the inner boundaries of the cave of Retzius on each side; and a posterior surface, which rests against the anterior wall of the vagina, except in its most superior part, where it is separated by peritoneum from the lowest part of the anterior surface of the uterus.

Remove all the fatty areolar tissue from the cave of Retzius and the extraperitoneal space above it on the left side and clean the upper surface of the pelvic diaphragm and the pelvic wall. The superior surface of the pelvic diaphragm is formed by the visceral layer of the pelvic fascia, which covers the upper surface of the levator ani muscle. It springs, as in the male, from the side wall of the pelvis, along a fascial band known as the *arcus tendineus*, which runs from the ischial spine to the lower border of the obturator canal, and then downward and medially across the internal surface of the pubis toward the symphysis. Posterior to the obturator canal the diaphragm arises from the parietal fascia covering the internal surface of the obturator internus muscle; anterior to the canal it arises directly from the bone.

This lateral portion of the visceral fascia is a single layer, in direct relation to the upper surface of the levator ani muscle, which may be seen through it; it is known as the rectal fascia. Posteriorly the rectal fascia is continued across the midline behind the rectum, still as a single layer, to become continuous with the same layer on the other side. Anterior to the rectum, as it approaches the midline, the visceral fascia is prolonged

upward to form a fascial covering for the vagina, and still higher on to the wall of the uterus. More anteriorly it is prolonged upward onto the sides of the bladder. Running forward from the neck of the bladder to the internal surface of the pubis slightly lateral to the midline, it presents a thickening, the anterior pubo-vesical ligament, or anterior true ligament of the bladder.

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ately anterior to the vagina, and ends below in the vestibule. It corresponds to the portion of the prostatic urethra in the male which lies above the opening of the prostatic utricle. (Compare Fig. 55.)

Draw the bladder forward and separate its posterior surface from the anterior surface of the vagina, to which it is loosely attached. At the same time separate the posterior surface of the urethra from the vagina and remove bladder and urethra from the pelvis. Then open the vagina by a longitudinal incision through its anterior wall and study its interior. It is a wide canal, whose anterior and posterior surfaces are usually in contact. Observe the rugae vaginales, transverse ridges found on both walls. Observe that the uterus projects downward into the upper part of the vagina, into which it opens by a small circular or oval aperture, the external uterine orifice. The portions of the vaginal canal which extends upward anterior and posterior to this lower portion of the uterus are known as the anterior and posterior fornices of the vagina.

Make a median longitudinal incision through the entire uterus to expose its lumen. Observe that there is a constriction of the lumen about half an inch above the external orifice. This is the internal orifice of the uterus and marks the junction of the body or upper portion of the uterus with the cervix or lower portion. The lining of the canal of the cervix is usually thrown into folds, while the lumen of the body has a smooth lining.

Cut through the vagina just above where it pierces the urogenital diaphragm and remove the upper part of the vagina and the uterus. Clean and study the muscles of the pelvic diaphragm. These do not differ from the same muscles in the male. The gap left between the two levator ani muscles anteriorly, which is filled in the male by the prostate, is filled in the female by the vagina and urethra.

THE SUPERIOR EXTREMITY

Certain bony landmarks should be identified before the skin is reflected from the superior extremity. The humerus is for the most part thickly covered by muscle, being subcutaneous only at its distal end, where the lateral and medial epicondyles form the subcutaneous bony prominences at either side of the elbow. The broad bony prominence at the back of the elbow is made by the olecranon process of the ulna. Continuing distally into the forearm from the olecranon is the dorsal border of the ulna, which is

subcutaneous throughout its length and ends on the dorso-medial aspect of the wrist in the styloid process of the ulna. The radius is more deeply placed, but its distal portion can usually be rather easily felt through the thin muscles and tendons which cover it. The bony projection at the lateral side of the wrist is the styloid process of the radius.

When the axilla was dissected an incision was made in the skin, crossing the anterior aspect of the arm transversely a little below the shoulder. This incision should now be extended so as completely to encircle the arm at this level, and any skin remaining in place above the level of this incision should be entirely removed. Then make a median longitudinal incision through the skin on the front of the arm and the forearm, extending from the upper transverse incision distally to the front of the wrist. Then make two transverse incisions, one across the front of the wrist from the medial to the lateral border, and another in front of the elbow, from the medial to the lateral epicondyle. This will mark out four skin flaps on the front of the arm and forearm, which should be reflected medially and laterally. Then, starting at the upper transverse incision on the back of the arm, reflect the skin downward off the back of the arm and forearm. The skin of the entire arm and forearm will then have been reflected in a single piece, which will remain attached only at the back of the wrist, where it is still continuous with the skin on the back of the hand.

The superficial veins of the upper extremity are numerous and variable. They may often be seen to better advantage in the living arm than in the dissecting room. The two largest and most constant are the cephalic vein and the basilic vein. These veins begin at the lateral (radial) and medial (ulnar) ends, respectively, of a venous arch on the dorsum of the hand. The cephalic vein should be found at the lateral side of the wrist and traced upward through the superficial fascia along the lateral side of the volar aspect of the forearm. Passing in front of the lateral side of the elbow, it ascends on the lateral aspect of the arm. The last part of its course, in the groove between the pectoralis major and deltoid muscles, and its termination in the axillary vein behind the clavicle, have already been seen. The basilic vein ascends along the ulnar border of the forearm, crosses in front of the medial side of the elbow to reach the medial aspect of the arm, and at about the middle of the arm pierces the deep fascia to join the deep veins which accompany the brachial artery. The median cubital vein is a large connect-

ing channel usually present in front of the elbow. It runs upward and medially from the cephalic to the basilic vein.

Clean and study the cutaneous nerves of the arm and forearm. These should be identified at the points at which they pierce the deep fascia, and their distributions traced. The main trunks and branches lie in relation to the deep surface of the superficial fascia, which should be removed from the arm and forearm as the nerves are cleaned. Clean first the nerves on the anterior aspect of the extremity.

The origins of the medial brachial and medial antibrachial cutaneous nerves from the medial cord of the brachial plexus have already been seen. The medial brachial cutaneous nerve pierces the deep fascia at about the middle of the medial aspect of the arm, usually just medial to the terminal part of the basilic vein. It descends on the medial side of the arm and just above the elbow turns posteriorly to supply the skin over the olecranon. The medial antibrachial nerve pierces the deep fascia slightly lower in the arm and usually lies just lateral to the basilic vein. It divides into an anterior and a posterior branch. Both of these descend into the forearm and supply the skin on the antero-medial and postero-medial aspects of the forearm as far down as the wrist.

The lateral antibrachial cutaneous nerve is a direct continuation of the musculocutaneous nerve. It will be found piercing the deep fascia on the antero-lateral aspect of the arm a short distance above the elbow, usually close to the cephalic vein. It is distributed to the skin on the lateral and antero-lateral aspects of the forearm as far as the wrist.

Turn to the back of the arm and identify the posterior and the lateral brachial cutaneous nerves. The posterior brachial cutaneous nerve is a branch of the radial nerve; it pierces the deep fascia on the postero-medial aspect of the arm near the border of the deltoid muscle and is distributed to the skin on the back of the arm below the deltoid. The lateral brachial cutaneous nerve is a branch of the axillary nerve; it pierces the deep fascia at about the middle of the posterior border of the deltoid and runs upward and laterally to supply the skin covering the lower half of that muscle.

The dorsal antibrachial cutaneous nerve is a branch of the radial nerve; its two terminal branches usually pierce the deep fascia on the dorsolateral aspect of the arm separately. The superior branch is relatively small; it appears about two inches above the lateral epicondyle and is distributed

to the lower half of the lateral and anterolateral aspects of the arm. The inferior branch is large; it emerges slightly below the superior branch, descends behind the lateral epicondyle, and supplies the skin on the back of the forearm as far as the wrist.

Now turn to the axilla, whose posterior and lateral walls were necessarily removed with the extremity. Review the brachial plexus and the axillary artery and their branches, and remove any traces of axillary fat which may remain. Identify the remains of the muscles by which the vertebral border of the scapula was attached to the axial skeleton, and

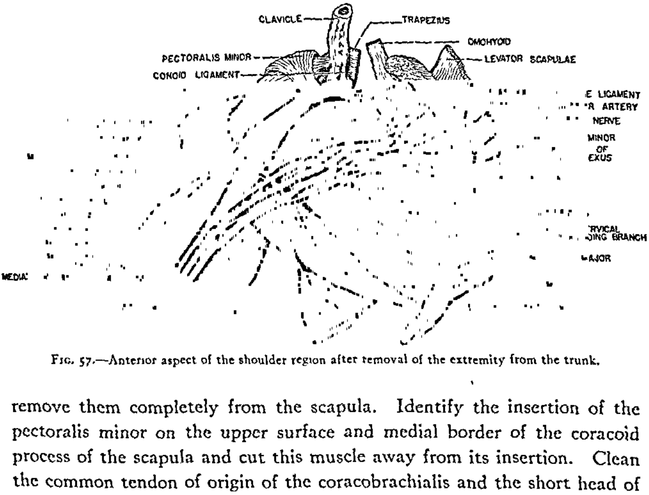

FIG. 57.—Anterior aspect of the shoulder region after removal of the extremity from the trunk.

remove them completely from the scapula. Identify the insertion of the pectoralis minor on the upper surface and medial border of the coracoid process of the scapula and cut this muscle away from its insertion. Clean the common tendon of origin of the coracobrachialis and the short head of the biceps brachii from the tip of the coracoid process and follow these muscles for a short distance into the arm. Observe that they separate from each other below the coracoid process, the coracobrachialis lying medial to the biceps, and that the long head of the biceps, here narrow and tendinous, emerges from under cover of the anterior border of the deltoid, to join the short head on its lateral side. The proximal portions of these muscles rest deeply against the anterior aspect of the humerus and are embraced

anteriorly by the tendon of insertion of the pectoralis major and posteriorly by the tendons of the latissimus *dorsi* and the *teres major*. (Fig. 57.)

Turn to the back of the scapula, review the insertion of the trapezius on the lateral third of the clavicle and the spine and acromion process of the scapula, and cut away the remains of this muscle. Then clean the deltoid. The deltoid is the large, thick, triangular muscle which forms the fleshy prominence of the shoulder. It arises by fleshy fibres from the anterior border and upper surface of the lateral third of the clavicle and the lateral border and upper surface of the acromion and by an aponeurosis from the spine of the scapula. Its fibres converge laterally and inferiorly to join a strong tendon which is inserted into the deltoid tuberosity of the humerus between the biceps and the lateral head of the triceps.

Cut the deltoid away from its origin and reflect it downward and laterally toward its insertion. As this is done care must be taken to avoid injury to the axillary nerve and the posterior humeral circumflex artery, which ramify on its deep surface. Then define and clean the infraspinatus, teres minor, and teres major muscles, and the upper part of the long head of the triceps brachii, all of which were partially covered by the posterior part of the deltoid. (Fig. 58.)

The infraspinatus occupies the infraspinous fossa of the scapula. It arises from the medial part of this fossa and to some extent from the layer of deep fascia which covers its outer surface. Its fibres converge laterally to join a strong flat tendon which is closely attached to the posterior part of the capsule of the shoulder joint and is inserted on the middle facet on the greater tuberosity of the humerus. The teres minor is a small muscle, which is often fused to a greater or less extent with the infraspinatus, immediately below which it lies. It arises from the middle portion of the axillary border of the infraspinous fossa; its fibres extend laterally to join a tendon which crosses the lower posterior part of the capsule of the shoulder joint, to be inserted on the lowest of the three facets on the greater tuberosity of the humerus. *The origin of the long head of the triceps is covered posteriorly* by the teres minor. It arises from the infraglenoid tuberosity at the lateral end of the axillary border of the scapula and descends in front of the teres minor and behind the teres major to reach the back of the arm. The teres major is a rounded fleshy muscle which arises from the medial part of the axillary border of the infraspinous fossa and extends laterally,

passing in front of the long head of the triceps to reach the anterior aspect of the humerus, where it is inserted into the medial lip of the intertubercular sulcus, under cover of the coracobrachialis muscle and the tendon of insertion of the latissimus dorsi.

The axillary nerve has already been seen to arise as a branch of the posterior cord of the brachial plexus within the axilla, which it leaves by passing between the adjacent borders of the subscapularis and teres major muscles, in company with the posterior humeral circumflex branch of the axillary artery. The nerve and artery may now be found reaching the back of the shoulder region by passing through a small quadrangular space

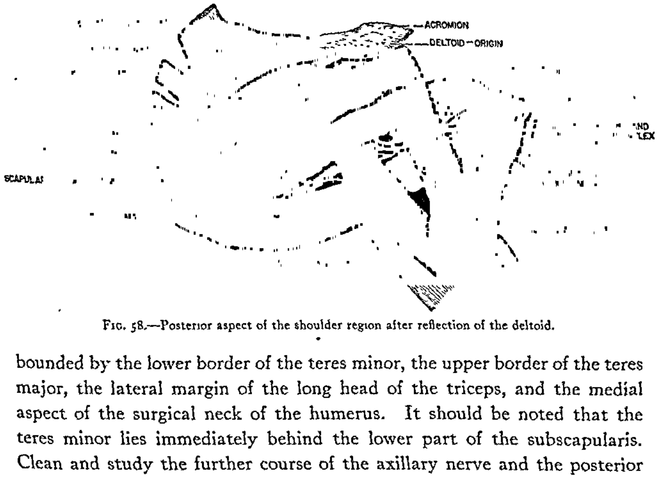

FIG. 58.—Posterior aspect of the shoulder region after reflection of the deltoid.

bounded by the lower border of the teres minor, the upper border of the teres major, the lateral margin of the long head of the triceps, and the medial aspect of the surgical neck of the humerus. It should be noted that the teres minor lies immediately behind the lower part of the subscapularis. Clean and study the further course of the axillary nerve and the posterior humeral circumflex artery. (Fig. 58.)

The axillary nerve, soon after it reaches the back of the shoulder, divides into a superior and an inferior division. The superior division is distributed entirely to the deltoid muscle, by numerous large twigs which enter the deep surface of the muscle. The inferior division gives rise to a branch which supplies the teres minor, and ends as the lateral brachial cutaneous nerve, which winds around the posterior border of the deltoid to reach the skin as

anteriorly by the tendon of insertion of the pectoralis major and posteriorly by the tendons of the latissimus dorsi and the teres major. (Fig. 57.)

Turn to the back of the scapula, review the insertion of the trapezius on the lateral third of the clavicle and the spine and acromion process of the scapula, and cut away the remains of this muscle. Then clean the deltoid. The deltoid is the large, thick, triangular muscle which forms the fleshy prominence of the shoulder. It arises by fleshy fibres from the anterior border and upper surface of the lateral third of the clavicle and the lateral border and upper surface of the acromion and by an aponeurosis from the spine of the scapula. Its fibres converge laterally and inferiorly to join a strong tendon which is inserted into the deltoid tuberosity of the humerus between the biceps and the lateral head of the triceps.

Cut the deltoid away from its origin and reflect it downward and laterally toward its insertion. As this is done care must be taken to avoid injury to the axillary nerve and the posterior humeral circumflex artery, which ramify on its deep surface. Then define and clean the infraspinatus, teres minor, and teres major muscles, and the upper part of the long head of the triceps brachii, all of which were partially covered by the posterior part of the deltoid. (Fig. 58.)

The infraspinatus occupies the infraspinous fossa of the scapula. It arises from the medial part of this fossa and to some extent from the layer of deep fascia which covers its outer surface. Its fibres converge laterally to join a strong flat tendon which is closely attached to the posterior part of the capsule of the shoulder joint and is inserted on the middle facet on the greater tuberosity of the humerus. The teres minor is a small muscle, which is often fused to a greater or less extent with the infraspinatus, immediately below which it lies. It arises from the middle portion of the axillary border of the infraspinous fossa; its fibres extend laterally to join a tendon which crosses the lower posterior part of the capsule of the shoulder joint, to be inserted on the lowest of the three facets on the greater tuberosity of the humerus. The origin of the long head of the triceps is covered posteriorly by the teres minor. It arises from the infraglenoid tuberosity at the lateral end of the axillary border of the scapula and descends in front of the teres minor and behind the teres major to reach the back of the arm. The teres major is a rounded fleshy muscle which arises from the medial part of the axillary border of the infraspinous fossa and extends laterally,

the shoulder joint. Then clean the supraspinatus muscle. (Figs. 58 and 59).

The supraspinatus occupies the supraspinous fossa, from the medial two-thirds of which its fibres take origin. Extending laterally to pass below the acromion and the coracoacromial ligament, the muscle fibres join a strong flat tendon, which is closely bound to the highest part of the capsule of the shoulder joint and is inserted into the highest of the three facets on the greater tuberosity of the humerus. Draw the superior border of the supraspinatus backward, to expose the superior border of the scapula. Clean the superior transverse ligament of the scapula. This is a strong fibrous band by which the notch in the superior border of the scapula is converted into a foramen. Observe that the suprascapular nerve, whose origin from the upper trunk of the brachial plexus in the posterior triangle of the neck has already been seen, passes through this foramen to enter the supraspinous fossa. The transverse scapular artery passes above the ligament to enter the supraspinous fossa close to the nerve. (Fig. 57.)

Divide the supraspinatus by an incision at right angles to the direction of its fibres; this incision should be made slightly lateral to the scapular notch. Then reflect the medial segment of the muscle backward and medially and follow the course of the suprascapular nerve. Observe that it runs inferiorly through the infraspinous fossa close to the bone, giving twigs of supply to the supraspinatus, and then passes through the great scapular notch to enter the infraspinous fossa. Attempt to define the inferior transverse ligament. This is a fibrous band, much less well-defined than is the superior ligament, which converts the medial part of the great scapular notch into a foramen through which both the suprascapular nerve and the transverse scapular artery pass from the supraspinous to the infraspinous fossa. (Fig. 60.)

Divide the infraspinatus about an inch and a half medial to its insertion and reflect the medial segment backward and medially from the bony surface of the infraspinous fossa. Observe that the suprascapular nerve terminates in twigs of supply to the infraspinatus. The transverse scapular artery is also distributed to the supraspinatus and infraspinatus. In a well injected specimen it will be apparent that it enters into anastomoses near the axillary border of the scapula with terminal branches of the scapular circumflex artery. The teres minor should also be divided, about an inch and a half

previously noted. It may also give a few additional twigs of supply to the deltoid. The largest branches of the posterior humeral circumflex artery accompany the branches of the superior division of the axillary nerve into the deltoid. A small branch winds anteriorly around the lateral side of the neck of the humerus to anastomose with the anterior humeral circumflex artery.

The origin of the scapular circumflex artery as a branch of the subscapular in the axilla has already been seen. It leaves the axilla by passing between the adjacent borders of the subscapularis and the teres major. Its continuation may now be seen between the teres minor and the teres major medial to the long head of the triceps. It is distributed to the muscles near the axillary border of the scapula.

The clavicle is joined to the scapula by means of a diarthrodial joint between the lateral end of the clavicle and the acromion process (articulatio acromioclavicularis) and a ligamentous union between the inferior surface of the flattened lateral part of the clavicle and the coracoid process (syndesmosis coracoclavicularis). These should now be studied. Push the clavicle upward from in front and clean the conoid and trapezoid ligaments; these are the two portions of the coracoclavicular ligament. The conoid ligament is the more medial; it is a strong fibrous cord which passes upward and laterally from the medial side of the root of the coracoid process to the conoid tubercle on the inferior surface of the clavicle. The trapezoid ligament is a flat fibrous band; it is attached below to a rough ridge on the medial border of the coracoid process, and above to an oblique line on the inferior surface of the clavicle, which runs forward and laterally from the conoid tubercle. (Fig. 57.) The acromioclavicular joint is a simple diarthrodial joint surrounded by a fibrous capsule which is attached to the margins of the opposing articular surfaces of the two bones. Open this capsule and observe the articular surfaces of the two bones. Divide the conoid and trapezoid ligaments and disarticulate the clavicle.

Clean the coracoacromial ligament. This is a flat, strong, fibrous band which arches above the shoulder joint from the lateral border of the coracoid process to the tip of the acromion; it is wider at its coracoid than at its acromial attachment. Open the subacromial bursa. This is a large mucous bursa which lies below the acromion and the coracoacromial ligament, between these structures and the muscles which cover the upper part of

the shoulder joint. Then clean the supraspinatus muscle. (Figs. 58 and 59).

The supraspinatus occupies the supraspinous fossa, from the medial two-thirds of which its fibres take origin. Extending laterally to pass below the acromion and the coracoacromial ligament, the muscle fibres join a strong flat tendon, which is closely bound to the highest part of the capsule of the shoulder joint and is inserted into the highest of the three facets on the greater tuberosity of the humerus. Draw the superior border of the supraspinatus backward, to expose the superior border of the scapula. Clean the superior transverse ligament of the scapula. This is a strong fibrous band by which the notch in the superior border of the scapula is converted into a foramen. Observe that the suprascapular nerve, whose origin from the upper trunk of the brachial plexus in the posterior triangle of the neck has already been seen, passes through this foramen to enter the supraspinous fossa. The transverse scapular artery passes above the ligament to enter the supraspinous fossa close to the nerve. (Fig. 57.)

Divide the supraspinatus by an incision at right angles to the direction of its fibres; this incision should be made slightly lateral to the scapular notch. Then reflect the medial segment of the muscle backward and medially and follow the course of the suprascapular nerve. Observe that it runs inferiorly through the infraspinous fossa close to the bone, giving twigs of supply to the supraspinatus, and then passes through the great scapular notch to enter the infraspinous fossa. Attempt to define the inferior transverse ligament. This is a fibrous band, much less well-defined than is the superior ligament, which converts the medial part of the great scapular notch into a foramen through which both the suprascapular nerve and the transverse scapular artery pass from the supraspinous to the infraspinous fossa. (Fig. 60.)

Divide the infraspinatus about an inch and a half medial to its insertion and reflect the medial segment backward and medially from the bony surface of the infraspinous fossa. Observe that the suprascapular nerve terminates in twigs of supply to the infraspinatus. The transverse scapular artery is also distributed to the supraspinatus and infraspinatus. In a well injected specimen it will be apparent that it enters into anastomoses near the axillary border of the scapula with terminal branches of the scapular circumflex artery. The teres minor should also be divided, about an inch and a half

medial to its insertion and its medial segment reflected, so as properly to expose the origin of the long *head of the triceps*. Observe that at its origin the long head lies between the teres minor and the lower part of the subscapularis.

Turn to the anterior aspect of the shoulder region and clean the subscapularis. This is a wide thick muscle which fills the entire subscapular fossa, from whose bony surface it takes origin. Stretching laterally across the front of the shoulder joint, the muscle narrows toward its insertion, which is on the lesser tuberosity of the humerus. Its tendon of insertion passes below the *coracoid process and behind the common origin of the* coracobrachialis and the short head of the biceps. The subscapularis is supplied by the upper subscapular nerve and by twigs from the lower subscapular nerve. Observe that the latter nerve is distributed principally to the teres major. Draw the upper border of the subscapularis forward and downward and open the *subscapular bursa.* This is a large mucous bursa which lies between the deep surface of the subscapularis and the inner surface of the scapula near the glenoid border; it communicates laterally with the cavity of the shoulder joint.

Clean the anterior surface of the teres major and the tendon of insertion of the latissimus dorsi, if this has not already been done, and examine the manner of insertion of these muscles. Observe that the tendon of the latissimus dorsi winds upward over the anterior surface of the teres major, to be inserted into the depth of the intertubercular sulcus, while the teres major is inserted into the medial lip of this sulcus. Both insertions lie behind the coracobrachialis and the biceps. The tendon of insertion of the pectoralis major should also be cleaned at this time. This tendon crosses in front of the coracobrachialis and the biceps to be inserted into the lateral lip of the intertubercular sulcus, under cover of the anterior border of the deltoid. (Fig. 59).

The origin of the *coracobrachialis has already been seen.* This muscle should now be cleaned to its insertion. Be careful, however, not to injure the brachial artery or the median nerve, which cross its surface. The coracobrachialis is a bandlike muscle whose fibres extend almost straight downward from their origin, to be inserted into the medial surface of the *humerus above the middle* of the shaft. It is partially overlapped on its lateral side by the biceps. Observe that the musculocutaneous nerve enters

the medial border of the muscle and passes obliquely downward through its substance to emerge under cover of the biceps. The coracobrachialis is supplied by a branch of the musculocutaneous nerve, which usually arises proximal to the point of entry of the main trunk into the muscle.

Clean the biceps brachii. The origin of its short head has already been seen. The long head arises within the capsule of the shoulder joint from the upper border of the glenoid fossa of the scapula. Its tendon may be seen now emerging from the capsule and descending in the intertubercular sulcus to join the short head. The fusiform belly of the biceps narrows below to a strong tendon which enters the cubital fossa, where its insertion on the tuberosity of the radius may more satisfactorily be seen later. As the distal part of the biceps is being cleaned, clean also the lacertus fibrosus. This is a thickened fibrous band, which passes medially and distally from the distal part of the medial border of the biceps to join the deep fascia on the proximal part of the medial side of the forearm. Draw the biceps forward and secure the nerves of supply which it receives from the musculocutaneous nerve.

The entire course of the musculocutaneous nerve may now be followed. It arises in the axilla as a branch of the lateral cord of the brachial plexus. It passes downward and laterally to enter the coracobrachialis, which it supplies. Emerging from the coracobrachialis it lies behind the biceps and descends between the biceps and the brachialis, both of which muscles it supplies. A short distance above the elbow it emerges from behind the lateral border of the biceps and pierces the deep fascia as the lateral antibrachial cutaneous nerve, whose further course has been traced. The brachialis is the thick fleshy muscle which lies behind the biceps in the lower part of the arm. Its attachments may more satisfactorily be seen later in the dissection. It should be noted now, however, that it is a large muscle and forms one of the main constituents of the anterior compartment of the arm.

The arm, below the level of the insertions of the deltoid and the coracobrachialis, is divided into two compartments, an anterior and a posterior, which are separated from each other by the humerus and the lateral and medial intermuscular septa. The lateral and medial intermuscular septa are strong aponeurotic fascial bands, which stretch laterally and medially from the lateral and medial supracondylar ridges of the humerus, to the deep surface of the deep fascia covering the lateral and medial surfaces, respectively, of the arm. They end inferiorly at the epicondyles, and superiorly

by blending with the fascia covering the deltoid and the coracobrachialis, respectively. The anterior compartment contains the brachialis and the lower part of the biceps and the origins of the brachioradialis and extensor carpi radialis longus muscles, and is traversed by the brachial artery and

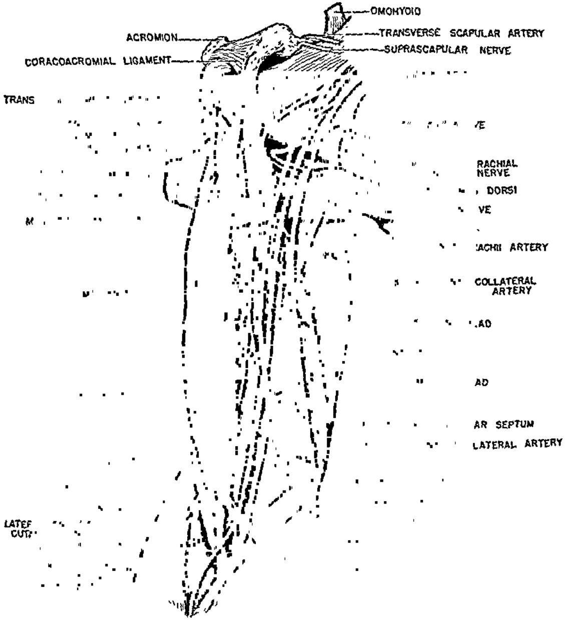

Fig. 59.—Dissection of the antero-medial aspect of the arm The biceps has been slightly displaced antero-laterally.

the median and musculocutaneous nerves. The posterior compartment contains the lower part of the triceps; through it pass the radial and ulnar nerves and the profunda brachii artery.

Clean the brachial artery. This vessel begins at the lower border of the teres major as a continuation of the axillary, and descends on the antero-

by blending with the fascia covering the deltoid and t
respectively. The anterior compartment contains the
lower part of the biceps and the origins of the brachio
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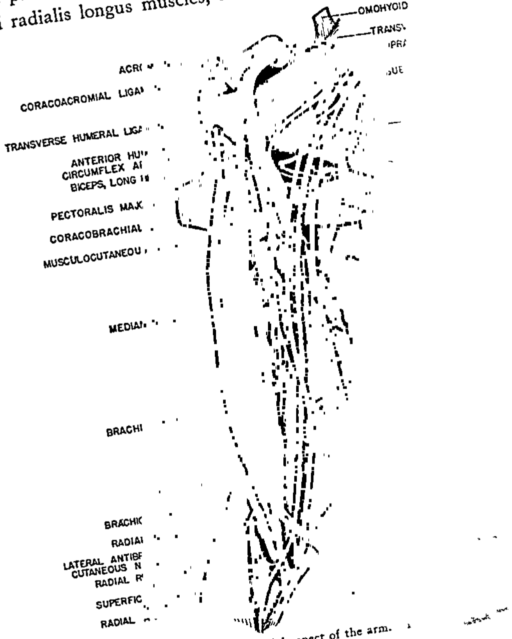

Fig. 59.—Dissection of the antero-medial aspect of the arm. ... laterally.

the median and musculocutaneous nerves. The
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nerves and the profunda brachii artery.

Clean the brachial artery. This vessel begins at the
the teres major as a continuation of the axillary, and descends on

The ulnar artery runs distally and medially, to leave the cubital fossa by passing deep to the pronator teres. In the fossa it gives rise to the volar and dorsal ulnar recurrent arteries, which may arise separately or by a common stem. The volar ulnar recurrent ascends between the pronator teres and the brachialis to anastomose with the anterior branch of the inferior ulnar collateral. The dorsal ulnar recurrent passes medially deep to the pronator teres. (Fig. 62.)

Clean the deep head of the pronator teres. This is a very small slip, sometimes entirely lacking, which arises from the medial border of the coronoid process of the ulna and joins the large superficial head. If it is present it will be found to intervene between the ulnar artery and the median nerve. The median nerve passes distally through the cubital fossa, lying medial to the brachial artery, and medial and anterior to the ulnar artery. It leaves the fossa by passing between the two heads of the pronator teres. In the fossa it gives a twig of supply to the pronator teres.

Clean the insertion of the biceps. This is on the tuberosity of the radius and is overlapped by the pronator teres. Spread the proximal parts of the brachioradialis and the extensor carpi radialis longus laterally away from the brachialis, to expose the terminal part of the radial nerve. The radial nerve enters the anterior compartment of the arm by piercing the lateral intermuscular septum close to the lateral supracondylar ridge of the humerus. It is accompanied by a branch of the profunda brachii artery, which here anastomoses with the radial recurrent. After giving branches to the brachioradialis and the extensor carpi radialis longus and one or two small twigs to the brachialis, the nerve ends by dividing into the superficial and deep radial nerves. The superficial radial nerve is a cutaneous branch; it passes distally in the forearm under cover of the brachioradialis. Some distance above the wrist it emerges from behind the lateral border of that muscle and winds dorsally around the lateral side of the wrist to reach the dorsum of the hand, where its distribution will be seen later. The deep radial nerve passes from view at present by entering the substance of the supinator. (Fig. 59.)

Displace the brachioradialis and the pronator teres as far to the lateral and medial sides as can conveniently be done, and clean and study the brachialis. This muscle arises from the entire anterior surface of the distal half of the humerus, from the entire anterior surface of the medial inter-

the pronator teres; its lateral boundary by the medial border of the brachioradialis. Its apex, which is directed distally, is the point where these two muscles meet. The pronator teres is the most lateral of the superficial group of muscles of the forearm which take origin by a common tendon from the medial epicondyle of the humerus. From this origin its fibres pass distally and laterally across the front of the forearm to be inserted on the middle third of the lateral surface of the radius; its insertion is covered by the brachioradialis. The brachioradialis is ordinarily grouped with the extensor muscles which spread over the back of the forearm and hand. It acts, however, principally as a flexor of the elbow and does not reach the hand at all. It may therefore well be cleaned and studied now. (Figs. 59 and 61.)

The brachioradialis arises from the upper two thirds of the lateral supracondylar ridge of the humerus and from the anterior surface of the lateral intermuscular septum. Its upper portion lies therefore in the anterior compartment of the arm, where it overlaps the lateral part of the brachialis. It extends distally along the lateral side of the volar surface of the forearm, and gives rise to a strong flat tendon which is inserted into the base of the styloid process of the radius. The most proximal portion of another muscle will also be seen in the anterior compartment. This is the extensor carpi radialis longus, which arises from the lateral supracondylar ridge immediately distal to the origin of the brachioradialis.

The floor of the cubital fossa is formed proximally by the lower part of the brachialis and distally by the supinator. Its roof is formed by skin and fascia and is crossed by the lacertus fibrosus. Within the fossa will be found the tendon of insertion of the biceps, the small deep head of the pronator teres, the median nerve, and the terminations of the brachial artery and the radial nerve and the beginnings of their terminal branches.

Clean first the radial and ulnar arteries. The radial artery passes distally and somewhat laterally from its origin, crossing in front of the tendon of the biceps, to leave the cubital fossa at its apex, where it lies in front of the pronator teres and is somewhat overlapped anteriorly by the brachioradialis. Near its origin it gives rise to the radial recurrent artery. This vessel runs laterally on the supinator and then turns proximally to ascend in front of the lateral epicondyle between the brachialis and the brachioradialis. (Fig. 59.)

before it enters the radial groove. The first of these is the posterior brachial cutaneous nerve, whose distribution to the skin on the back of the arm has already been traced. The second supplies the long head of the triceps. The third is distributed to the medial head; it is sometimes known as the

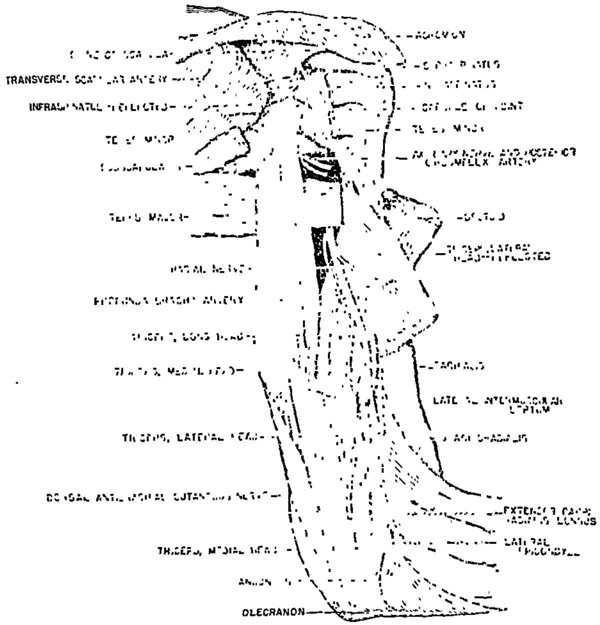

Fig. 60.—Dissection of the postero-lateral aspect of the arm.

ulnar collateral nerve, from the fact that it descends on the external surface of the medial head close to the ulnar nerve for some distance before finally entering the substance of the muscle. (Fig. 59.)

In the radial groove the radial nerve passes laterally and distally between the medial and lateral heads of the triceps. At the distal end of the radial

muscular septum, and from the anterior surtace of the lateral intermuscular septum proximal to the origin of the brachioradialis. Its distal portion lies in front of the capsule of the elbow joint, to which it is closely bound, and narrows to a strong tendon which is inserted on the tuberosity of the ulna. Its nerve supply is derived chiefly from the musculocutaneous nerve, but it receives additional small twigs from the radial.

Turn to the back of the arm and clean the triceps brachii. The lower part of this muscle occupies the entire posterior compartment of the arm. It arises by three heads, which are all inserted by a common tendon on the olecranon of the ulna. The origin of the long head from the axillary border of the scapula has already been cleaned. The medial and lateral heads arise from the posterior aspect of the humerus; the origins of these two heads are separated by the spiral sulcus for the radial nerve. The lateral head arises from the superior lateral portion of the posterior surface of the humerus. The origin of the medial head is lower and much more extensive, and is partly covered by both the long and the lateral heads. The medial head arises from the entire posterior surface of the humerus below and medial to the radial groove, from the entire posterior surface of the medial intermuscular septum, and from the lower part of the posterior surface of the lateral intermuscular septum. The common tendon of insertion of the triceps forms a strong aponeurotic band on the posterior surface of the distal part of the muscle; it is inserted into the proximal surface of the olecranon. Observe that the ulnar nerve lies on the external surface of the medial head, close to the medial intermuscular septum, as it descends through the arm to pass behind the medial epicondyle. It is joined at about the middle of the arm by the superior ulnar collateral artery, which here pierces the medial intermuscular septum. Separate the three heads of the triceps as completely as possible. Then divide the lateral head transversely at about the middle of the arm, and reflect its upper segment laterally and forward to expose the radial groove. Clean the radial nerve and the profunda brachii artery.

The radial nerve arises in the axilla from the posterior cord of the brachial plexus. It crosses the subscapularis, the teres major, the tendon of the latissimus dorsi, and the long head of the triceps, and then enters the radial groove on the back of the humerus, by passing between the long and medial heads of the triceps. Three branches arise from the radial nerve

the inside. Divide the posterior part of the capsule vertically and turn the head of the humerus laterally and posteriorly, so that the internal surface of the anterior part of the capsule may be seen. The superior glenohumeral ligament stretches from the glenoid border at the root of the coracoid downward and laterally to the summit of the lesser tuberosity. The middle and inferior glenohumeral ligaments are less distinct thickenings in the lower anterior part of the capsule. The opening into the subscapular bursa lies between the superior and the middle glenohumeral ligaments.

Observe that the tendon of the long head of the biceps arises from the supraglenoid tubercle of the scapula and passes through the articular cavity to reach the intertubercular sulcus. Divide this tendon and the anterior part of the capsule and separate the humerus from the scapula. Observe the glenoid lip. This is a narrow, fibrocartilaginous ring, which surmounts the edge of the glenoid cavity and slightly deepens it.

The skin should now be reflected from the hand. To do this make the following incisions: (1) a median longitudinal incision through the skin of the palm from the middle of the transverse incision already made across the wrist, to the tip of the middle finger; (2) a transverse incision across the palm at the proximal ends of the fingers; (3) an oblique incision from the middle of the front of the wrist to the tip of the thumb; (4) longitudinal incisions from incision 2 distally along the middle of the volar surfaces of the index, ring, and little fingers, to their tips. Starting with these incisions, reflect the skin first from the volar and then the dorsal surfaces of the hand and fingers, and remove it completely from the extremity.

Turn to the dorsum of the hand and clean the superficial venous arch from which the cephalic and basilic veins arise. This arch is derived from a dorsal venous plexus on the distal part of the back of the hand and on the fingers.

Clean the cutaneous nerves on the dorsum of the hand. The superficial radial nerve has already been seen to emerge from under cover of the lateral border of the brachioradialis and wind dorsally around the lateral side of the distal part of the forearm just proximal to the wrist. Reaching the lateral side of the dorsum of the wrist, it divides into branches which supply the skin on the lateral half of the dorsum of the hand, the dorsal surfaces of the thumb, index, and middle fingers, and usually the lateral

groove it pierces the lateral intermuscular septum, to enter the anterior compartment of the arm, where its further course has been seen. In the radial groove it gives rise to a branch to the lateral head, a second branch to the medial head, and to the dorsal antibrachial cutaneous nerve. The latter nerve passes through the substance of the triceps to reach the posterolateral surface of the arm, from which point it has been traced. (Fig. 60.)

The profunda brachii is a branch of the brachial artery. It accompanies the radial nerve into the radial groove. It is distributed principally to the triceps. One branch, however, known as the radial collateral artery, accompanies the nerve into the anterior compartment to anastomose with the radial recurrent artery. Another branch usually ascends deep to the deltoid to anastomose with the posterior humeral circumflex.

The shoulder joint should next be studied. Cleaning of its articular capsule will be facilitated if the following procedure is followed. Divide the coracoacromial ligament along its line of attachment to the coracoid. Then saw through the acromion at its junction with the scapular spine and remove the acromion and the coracoacromial ligament. The fibrous capsule of the shoulder joint is attached medially to the margin of the glenoid fossa and laterally to the anatomical neck of the humerus. It is almost entirely surrounded by the muscles which pass from the scapula to the tuberosities of the humerus. The supraspinatus, infraspinatus, and teres minor have already been divided; reflect the lateral segments of these muscles laterally and posteriorly toward their insertions and observe how closely they are bound to the articular capsule. Anteriorly the capsule is covered by the subscapularis. Divide this muscle about two inches medial to the lesser tuberosity and reflect its lateral segment forward and laterally. As this is done the opening in the fibrous capsule by which the articular cavity communicates with the subscapular bursa will be exposed.

Clean the coracohumeral ligament. This ligament is a strong band which stretches from the lateral border of the coracoid downward and laterally to the upper part of the greater tuberosity. It is distinctly separable from the fibrous capsule only at its medial end. The transverse ligament of the humerus is a fibrous band, closely connected with the capsule, which extends between the two tuberosities, roofing over the proximal portion of the intertubercular sulcus. The glenohumeral ligaments are thickenings in the anterior part of the capsule, which may best be seen from

the inside. Divide the posterior part of the capsule vertically and turn the head of the humerus laterally and posteriorly, so that the internal surface of the anterior part of the capsule may be seen. The superior glenohumeral ligament stretches from the glenoid border at the root of the coracoid downward and laterally to the summit of the lesser tuberosity. The middle and inferior glenohumeral ligaments are less distinct thickenings in the lower anterior part of the capsule. The opening into the subscapular bursa lies between the superior and the middle glenohumeral ligaments.

Observe that the tendon of the long head of the biceps arises from the supraglenoid tubercle of the scapula and passes through the articular cavity to reach the intertubercular sulcus. Divide this tendon and the anterior part of the capsule and separate the humerus from the scapula. Observe the glenoid lip. This is a narrow, fibrocartilaginous ring, which surmounts the edge of the glenoid cavity and slightly deepens it.

The skin should now be reflected from the hand. To do this make the following incisions: (1) a median longitudinal incision through the skin of the palm from the middle of the transverse incision already made across the wrist, to the tip of the middle finger; (2) a transverse incision across the palm at the proximal ends of the fingers; (3) an oblique incision from the middle of the front of the wrist to the tip of the thumb; (4) longitudinal incisions from incision 2 distally along the middle of the volar surfaces of the index, ring, and little fingers, to their tips. Starting with these incisions, reflect the skin first from the volar and then the dorsal surfaces of the hand and fingers, and remove it completely from the extremity.

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Clean the cutaneous nerves on the dorsum of the hand. The superficial radial nerve has already been seen to emerge from under cover of the lateral border of the brachioradialis and wind dorsally around the lateral side of the distal part of the forearm just proximal to the wrist. Reaching the lateral side of the dorsum of the wrist, it divides into branches which supply the skin on the lateral half of the dorsum of the hand, the dorsal surfaces of the thumb, index, and middle fingers, and usually the lateral

side of the dorsum of the ring finger. The posterior cutaneous branch of the ulnar nerve will be found winding dorsally around the medial border of the wrist, to be distributed to the skin on the medial half of the dorsum of the hand, the dorsum of the little finger, and the medial side of the dorsum of the ring finger.

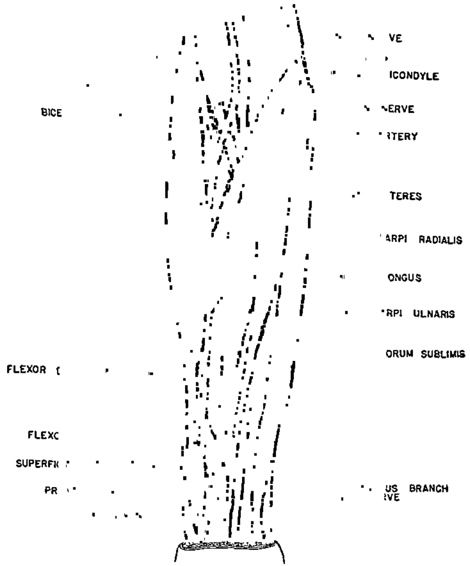

FIG. 61 —Superficial dissection of the volar aspect of the forearm.

Turn to the volar aspect of the forearm. The volar and medial portions of the forearm are occupied by the muscles which flex the wrist and the fingers and pronate the hand. These muscles are arranged in three layers, the most superficial of which should now be cleaned. The muscles of the superficial layer arise by a common tendon from the medial epicondyle of the humerus, and from the deep fascia which invests their proximal portions. They spread distally and laterally over the volar aspect of the forearm, becoming distinct

from one another two or three inches distal to the medial epicondyle. They are, in order from lateral to medial, the pronator teres, the flexor carpi radialis, the palmaris longus, and the flexor carpi ulnaris.

The pronator teres has already been cleaned. Observe that near its insertion it is crossed by the radial artery and overlapped by the brachioradialis. The flexor carpi radialis narrows to a rounded tendon which descends along the medial side of the radial artery, and enters the palm superficially, where its insertion on the base of the second metacarpal may better be seen later.

The tendon of the palmaris longus crosses the middle of the front of the wrist, lying, in the distal part of the forearm, immediately in front of the median nerve, and is inserted into the palmar aponeurosis. In about twelve per cent of cases this muscle is absent; in such cases the median nerve is superficial just above the wrist.

The flexor carpi ulnaris arises by the common tendon from the medial epicondyle, but has a second head of origin from the medial border of the olecranon and from an aponeurosis attached to the proximal two-thirds of the dorsal border of the ulna. It is inserted into the pisiform bone. Observe that the ulnar nerve passes behind the medial epicondyle and enters the forearm by passing deep to a fibrous arch which unites the two heads of origin of the flexor carpi ulnaris.

Clean the palmar aponeurosis. This is a dense thickening of the deep fascia of the palm, which radiates from the tendon of the palmaris longus toward the bases of the fingers, where it divides into four slips which join the fibrous sheaths by which the flexor tendons are held in place against the volar surfaces of the phalanges.

Divide the pronator teres about an inch medial to its insertion; divide the tendons of the flexor carpi radialis, the palmaris longus, and the flexor carpi ulnaris about two inches proximal to the wrist. Then reflect the proximal segments of all four muscles together, medially toward their origin. As this is done, secure and clean the nerves which enter their deep surfaces. The pronator teres is supplied by a branch of the median nerve which arises in the cubital fossa. The flexor carpi radialis and the palmaris longus are supplied by branches arising from the median nerve under cover of the pronator teres. The flexor carpi ulnaris is supplied by two or three twigs from the ulnar nerve in the upper part of the forearm. (Fig. 62.)

side of the dorsum of the ring finger. The posterior cutaneous branch of the ulnar nerve will be found winding dorsally around the medial border of the wrist, to be distributed to the skin on the medial half of the dorsum of the hand, the dorsum of the little finger, and the medial side of the dorsum of the ring finger.

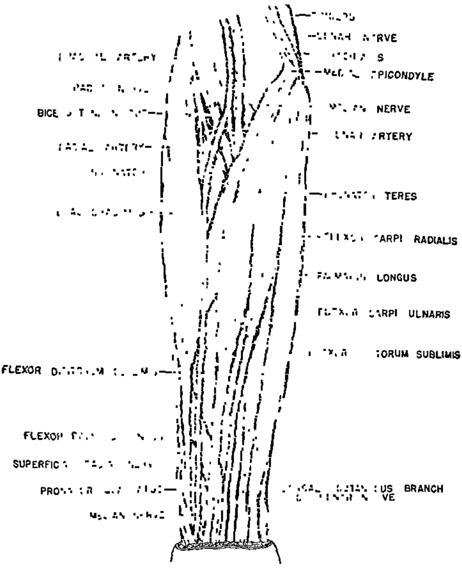

Fig. 61.—Superficial dissection of the volar aspect of the forearm.

Turn to the volar aspect of the forearm. The volar and medial portions of the forearm are occupied by the muscles which flex the wrist and the fingers and pronate the hand. These muscles are arranged in three layers, the most superficial of which should now be cleaned. The muscles of the superficial layer arise by a common tendon from the medial epicondyle of the humerus, and from the deep fascia which invests their proximal portions. They spread distally and laterally over the volar aspect of the forearm, becoming distinct

The deepest layer of the volar muscles of the forearm includes the flexor pollicis longus, the flexor digitorum profundus, and the pronator quadratus. Before studying these muscles in detail, however, it is best to study the course in the forearm of the radial and ulnar arteries and the median and ulnar nerves. The radial artery is superficial throughout its course in the

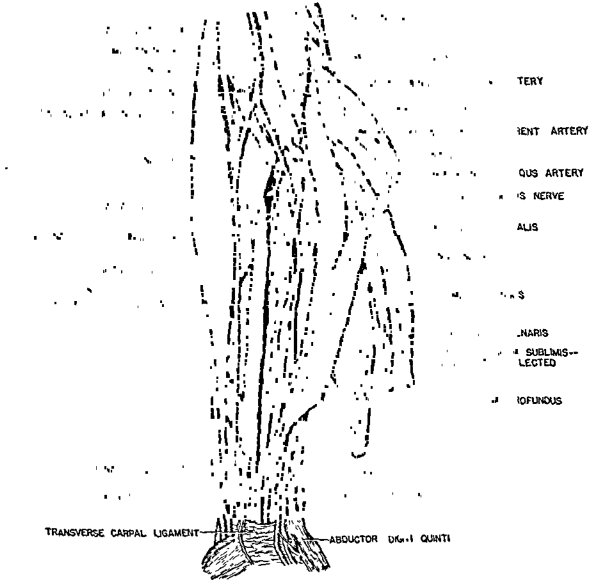

FIG. 62.—Deep dissection of the volar aspect of the forearm. The muscles of the superficial group and the radial head of the flexor digitorum sublimis have been severed and turned medially.

forearm, with the exception that distal to the apex of the cubital fossa it is overlapped for a variable distance on its lateral side by the brachioradialis. Deeply it rests successively against the tendon of the biceps, the supinator, the insertion of the pronator teres, the radial head of the flexor digitorum sublimis, the flexor pollicis longus, the pronator quadratus, and the volar surface of the radius. Just proximal to the wrist it turns laterally and

Reflect the palmar aponeurosis, together with the attached tendon of insertion of the palmaris longus, forward and distally from the palm. This must be carefully done, to avoid injury to the superficial volar arterial arch, and the terminal part of the median nerve, which lie immediately subjacent to the aponeurosis in the palm of the hand. When it has been reflected; the palmar aponeurosis may be cut away at the bases of the fingers, where its four divergent slips join the fibrous sheaths of the flexor tendons, and entirely removed.

The second layer of the volar aspect of the forearm is represented by a single large muscle, the flexor digitorum sublimis, which should now be cleaned. It arises in part from the medial epicondyle of the humerus, in common with the more superficial muscles; it has, however, a more extensive origin from the medial borders of the ulnar tuberosity and the coronoid process of the ulna, from the oblique line on the volar surface of the radius, and from a fibrous arch which bridges across the gap between its ulnar and radial origins. Observe that the median nerve and the ulnar artery pass into the forearm behind this fibrous arch. As the wrist is approached, the muscle divides into four tendons, of which those for the middle and ring fingers are superficial and those for the index and little fingers lie behind them. All four tendons pass behind the transverse carpal ligament, where they are enclosed in a single mucous sheath, which is common to them and to the four tendons of the flexor digitorum profundus, to enter the palm of the hand.

It is advisable at this stage of the dissection to clean the volar carpal and transverse carpal ligaments. The transverse carpal ligament is a strong, dense, fibrous band, which stretches across the carpus, and together with the volar surfaces of the carpal bones, completes an osteo-fibrous tunnel through which the flexor tendons of the digits, and the trunk of the median nerve enter the palm. It is attached laterally to the navicular and greater multangular bones and medially to the pisiform and the hook of the hamate. The tendon of the flexor carpi radialis pierces the lateral end of the transverse carpal ligament as it crosses the wrist. The ulnar nerve and artery cross the medial end of the ligament superficially to enter the palm. They are held in place against the transverse carpal ligament by the volar carpal ligament. The latter is a thinner fibrous band which is attached medially to the pisiform bone and the hook of the hamate, and laterally to the volar surface of the transverse carpal ligament.

interosseous membrane, where it is covered by the overlapping borders of the flexor pollicis longus and the flexor digitorum profundus. Hence it can better be studied when these muscles have been cleaned. Near its origin, however, it gives rise to a branch known as the median artery, which accompanies the median nerve. While usually small and unimportant, the median artery is occasionally considerably enlarged, and may accompany the nerve into the hand and take part in the formation of the superficial volar arch.

In its course through the forearm the ulnar artery gives rise to numerous muscular branches. Near the proximal border of the transverse carpal ligament it gives rise to a dorsal ulnar carpal branch, which winds medially and dorsally to reach the dorsal surface of the carpus. The volar ulnar carpal branch arises at about the same level and passes laterally deep to the flexor tendons to anastomose with the volar radial carpal.

The ulnar nerve enters the forearm by passing between the two heads of the flexor carpi ulnaris. In its whole course through the forearm it is covered *only by that muscle. Proximally the ulnar nerve is separated* from the ulnar artery by the flexor digitorum sublimis, but distally it closely accompanies the artery, lying on the medial side of the latter. In the proximal part of the forearm the ulnar nerve gives branches which supply the flexor carpi ulnaris and the medial portion of the flexor digitorum profundus; in the distal part of the forearm it gives rise to the posterior cutaneous branch whose distribution to the skin on the dorsum of the hand has already been traced, and to a small palmar cutaneous branch, which passes in front of the ulnar artery to reach the skin on the medial half of the palm. Near the distal border of the transverse carpal ligament the ulnar nerve terminates by dividing into a deep and a superficial branch.

The median nerve runs almost vertically through the forearm, to pass behind the transverse carpal ligament, in company with the flexor tendons, into the hand. In the upper two-thirds of the forearm it lies between the flexors digitorum sublimis and profundus; in the distal third it is covered superficially only by the tendon of the palmaris longus. In the cubital fossa, or just distal to it under cover of the pronator teres, it gives rise to branches which supply the pronator teres, the flexor carpi radialis, the palmaris longus, and the flexor digitorum sublimis. Slightly more distally it gives rise to a branch known as the volar interosseous nerve; this nerve

dorsally toward the back of the wrist, where its further course will be traced later.

In addition to the radial recurrent artery, which has already been cleaned, the radial artery gives rise in the forearm to numerous small muscular branches, and to a volar radial carpal and a superficial volar branch. The volar radial carpal is a small branch, which passes medially across the distal end of the radius, deep to the flexor tendons, to anastomose with the volar carpal branch of the ulnar artery. The superficial volar branch arises just as the radial turns dorsally at the wrist and runs forward over or through the short muscles of the ball of the thumb to take part in the formation of the superficial volar arch.

Detach the radial head of origin of the flexor digitorum sublimis from the radius and displace the whole muscle medially. Then clean the ulnar artery. The ulnar artery is deeply placed in the proximal half of the forearm, being covered by the four muscles of the superficial layer and by the flexor digitorum sublimis. It is also crossed, under cover of the pronator teres, by the median nerve, which here passes from its medial to its lateral side. In the distal half of the forearm the ulnar artery is more superficial, being merely overlapped by the tendon of the flexor carpi ulnaris. Deeply it rests first upon the brachialis, and then for the remainder of its course through the forearm, upon the flexor digitorum profundus; at the wrist it crosses the medial end of the transverse carpal ligament superficially to enter the palm.

The origin of the ulnar recurrent arteries has already been seen. The further course of the dorsal ulnar recurrent may now be traced. It ascends between the flexors digitorum sublimis and profundus, to pass behind the medial epicondyle and anastomose with the superior ulnar collateral and the posterior branch of the inferior ulnar collateral.

The common interosseous artery arises from the ulnar near the point where that vessel is crossed by the median nerve. It passes backward and distally between the adjacent borders of the flexor pollicis longus and the flexor digitorum profundus, and shortly divides into the dorsal and the volar interosseous arteries. The dorsal interosseous passes straight backward, between the proximal ends of the radius and ulna, and above the proximal border of the interosseous membrane, to reach the dorsal aspect of the forearm. The volar interosseous passes distally in front of the

the opponens, and the adductor of the thumb, which form the thenar eminence, or ball of the thumb; and the lumbrical and interosseous muscles, which lie on a deeper plane in the middle of the palm. Before cleaning these muscles, clean and study the superficial volar arch and the superficial branch of the ulnar nerve. (Fig. 63.)

The superficial volar arch is formed principally by the continuation of the ulnar artery into the palm, but is usually completed on its lateral side by the superficial volar branch of the radial artery. As it reaches the distal

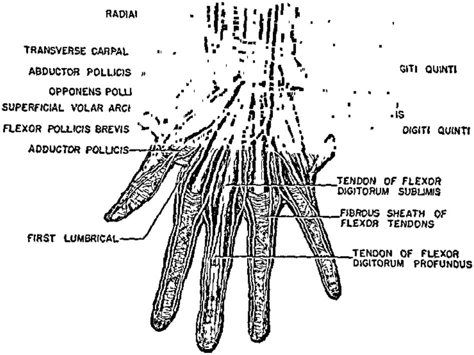

FIG. 63.—Superficial dissection of the palm after removal of the palmar aponeurosis. The fibrous sheath has been removed from the middle finger, to expose the insertions of the flexor tendons.

border of the transverse carpal ligament the ulnar artery gives off a deep branch, which accompanies the deep branch of the ulnar nerve deeply into the palm by passing between the short muscles of the little finger. The ulnar artery is then continued as the superficial arch. This arch crosses the palm at about the level of the middle of the metacarpal bones. The superficial volar branch of the radial artery may cross the base of the thenar eminence superficially to join the arch or may pass deep to the abductor pollicis brevis. The branches of the superficial volar arch are somewhat variable, but usually include a proper volar digital artery for the medial side of the little finger, and three common volar digital arteries. The latter pass distally superficial to the three medial interosseous spaces; at the bases of the interdigital clefts each divides into two proper digital arteries, which

accompanies the volar interosseous artery along the volar surface of the interosseous membrane, and is distributed to the flexor pollicis longus, the lateral part of the flexor digitorum profundus, and the pronator quadratus. Immediately above the transverse carpal ligament the median nerve gives a small palmar cutaneous branch, which crosses the ligament superficially to supply the skin of the lateral half of the palm.

Now clean the deep volar muscles. The flexor digitorum profundus has a wide fleshy origin from the proximal two thirds of the volar and the medial surfaces of the ulna, and the adjacent part of the interosseous membrane; it also derives some fibres from the deep surface of the aponeurosis of the flexor carpi ulnaris on the dorsal border of the ulna. The muscle gives rise to four tendons which pass into the hand side by side, deep to the transverse carpal ligament and the tendons of the flexor digitorum sublimis. The flexor pollicis longus arises from the middle half of the volar surface of the radius and from the adjacent portion of the interosseous membrane; the origin of this muscle is limited proximo-laterally by the line of origin of the radial head of the flexor digitorum sublimis. Its tendon passes deep to the transverse carpal ligament, where it lies lateral to the first tendon of the flexor digitorum profundus.

Spread the flexors digitorum profundus and pollicis longus apart, to expose the pronator quadratus and the volar interosseous artery and nerve. The pronator quadratus is a flat, quadrangular muscle which arises from the medial side of the distal fourth of the volar surface of the ulna. Its fibres pass transversely to be inserted on the volar surface of the radius.

The volar interosseous artery descends in front of the interosseous membrane, supplying branches to the deep flexors. It ends at the proximal border of the pronator quadratus by dividing into posterior and anterior terminal branches. The larger posterior branch pierces the interosseous membrane to reach the back of the forearm. The anterior branch descends deep to the pronator quadratus to anastomose with the volar carpal branches of the radial and ulnar arteries. The volar interosseous nerve accompanies the artery. It is distributed to the three deep muscles, and also sends a twig which accompanies the anterior branch of the artery to the wrist joint.

The short muscles of the hand include the abductor, the short flexor, and the opponens of the little finger, which together form the hypothenar eminence on the medial side of the palm; the short abductor, the short flexor,

thus forming in each finger an osteofibrous canal through which the flexor tendons pass to their insertions. Their strongest portions, known as the digital vaginal ligaments, lie opposite the bodies of the first and second phalanges of each finger. (Fig. 63.)

Trace the distribution of the median nerve in the palm. As it emerges from under cover of the transverse carpal ligament, the median nerve terminates by dividing into three common volar digital nerves. The first of these, passing distally and laterally, supplies the short abductor, the short flexor, and the opponens of the thumb, and the first lumbrical muscle, and then divides into three proper volar digital nerves, which supply the skin on both sides of the thumb and the lateral side of the index finger. The second and third common volar digital branches each divide into two proper volar digitals, which supply the medial side of the index finger, both sides of the middle finger, and the lateral side of the ring finger. The second common volar digital usually also gives a twig to the second lumbrical.

Now study the long flexor tendons in the palm. The transverse carpal ligament may be divided, to render the tendons more accessible for study. Observe that as they emerge from under cover of the transverse carpal ligament, the tendons of the long flexors diverge toward the bases of the fingers, the tendon of the flexor sublimis lying in each case superficial to that of the flexor profundus. Open the fibrous sheath in one or two of the fingers by a longitudinal incision, to study the manner of insertion of the two tendons. Observe that in front of the body of the first phalanx the tendon of the flexor sublimis is pierced by the tendon of the flexor profundus. The sublimis tendon is then inserted on the base of the second phalanx, while the tendon of the profundus passes distally to be inserted on the base of the terminal phalanx. (Fig. 63.)

Divide the tendons of the flexor digitorum sublimis at about the level of the distal border of the transverse carpal ligament and turn them distally toward their insertions. Then clean the lumbrical muscles. These are four small muscles which arise in the distal part of the palm from the tendons of the flexor digitorum profundus. The first arises from the lateral border of the tendon for the index finger and the second from the lateral border of the tendon for the middle finger; the third and fourth each take origin from the adjacent sides of two tendons. Each passes distally around the lateral side of the base of a finger and ends in a slender tendon which is

supply the medial side of the index finger, both sides of the middle and ring fingers, and the lateral side of the little finger.

The superficial branch of the ulnar nerve terminates in the palm by dividing into three volar digital branches, which are distributed to the skin of both sides of the little finger and the medial side of the ring finger.

Clean the short muscles of the little finger. The abductor digiti quinti is the most medial; it arises from the pisiform bone and is inserted into the medial side of the base of the first phalanx of the little finger. The flexor digiti quinti brevis arises from the hook of the hamate and the medial end of the transverse carpal ligament, and is inserted with the abductor. The opponens digiti quinti is covered superficially by the short flexor, with which it is often partially blended. The opponens arises from the hook of the hamate and the adjacent border of the transverse carpal ligament and is inserted into the whole length of the medial volar surface of the fifth metacarpal. All three of these muscles are supplied by twigs from the deep branch of the ulnar nerve. Observe that the deep branches of the ulnar nerve and artery pass between the origins of the abductor and the flexor brevis as they sink into the palm.

Attempt to demonstrate the mucous sheaths of the flexor tendons in the palm. Two mucous sheaths envelope the flexor tendons as they pass behind the transverse carpal ligament. One of these encloses the tendon of the flexor pollicis longus; it extends from near the proximal border of the transverse carpal ligament almost to the insertion of the tendon. The second mucous sheath encloses the four tendons of the flexor digitorum sublimis and the four tendons of the flexor digitorum profundus. It begins about an inch proximal to the proximal border of the transverse carpal ligament and extends distally for about an inch beyond the distal border of the ligament. Its most medial portion, however, is prolonged distally, to enclose the two flexor tendons for the little finger, within their fibrous sheath, as far as the base of the terminal phalanx. Three individual mucous sheaths enclose the tendons of the index, middle, and ring fingers, within their fibrous sheaths. These extend, in each case, from the level of the metacarpo-phalangeal joint to the base of the terminal phalanx.

The fibrous sheaths of the flexor tendons may also be investigated at this time. These are bands of fibrous tissue which are attached to the margins of the phalanges and bridge across the volar aspects of the latter,

space, where the radial artery enters the palm. The arch is formed principally by the palmar continuation of the radial artery, but is completed medially by the deep branch of the ulnar artery, which enters the palm under cover of the flexor digiti quinti brevis. If the latter muscle is now detached from its origin and reflected, the full course of the deep volar arch will be exposed. It crosses the palm at the level of the bases of the metacarpal bones, resting deeply against the proximal portions of the interosseous muscles. Its two largest branches arise from its lateral end, at the base of the first interosseous space. They are the princeps pollicis and the lateral volar artery of the index finger. The princeps pollicis passes along the metacarpal of the thumb, under cover of the oblique head of the adductor, and at the base of the first phalanx divides into two branches, which are distributed to the two sides of the volar aspect of the thumb. The lateral volar artery of the index finger passes distally under cover of the transverse head of the adductor, to reach the lateral side of the index finger. In addition to these branches the deep volar arch gives rise to three volar metacarpal branches, which descend in the three medial interosseous spaces to anastomose with the volar digital branches of the superficial arch.

The deep branch of the ulnar nerve accompanies the medial part of the deep volar arch. It is distributed to the three short muscles of the little finger, the third and fourth lumbricals, the adductor pollicis, and all of the interosseous muscles.

The interossei are small muscles which occupy the interosseous spaces. They are arranged in two groups, consisting of three volar and four dorsal interossei. Detach the transverse head of the adductor pollicis from its origin and reflect it laterally. Then clean and study the interossei. The first volar interosseous muscle arises from the medial volar surface of the second metacarpal and is inserted into the medial side of the base of the first phalanx of the index finger. The second and third volar interossei arise from the lateral volar surfaces of the fourth and fifth metacarpals, respectively, and are inserted into the lateral sides of the bases of the first phalanges of the ring and little fingers. The dorsal interossei lie on a slightly deeper plane; one dorsal interosseous muscle is found in each space, each arising from the adjacent sides of two metacarpals. The first and second are inserted into the lateral sides of the bases of the first phalanges of the index and middle fingers, respectively. The third and fourth are inserted into

inserted into the corresponding extensor tendon on the dorsum of that finger.

Clean the short muscles of the thumb. Of these the abductor pollicis brevis is the most superficial. It arises from the greater multangular bone and the lateral end of the transverse carpal ligament and is inserted into the lateral side of the base of the first phalanx of the thumb. When it has been cleaned it should be detached from its origin and reflected toward its insertion, to expose the deeper muscles. The opponens pollicis is a thick, fleshy muscle, which arises from the greater multangular bone and the adjacent part of the transverse carpal ligament and is inserted into the lateral side of the entire volar surface of the metacarpal of the thumb. The flexor pollicis brevis is divided into a deep and a superficial portion by the tendon of the flexor pollicis longus. The superficial portion lies along the medial side of the opponens pollicis and covers the tendon of the flexor longus. It arises from the greater multangular and the transverse carpal ligament and is inserted into the base of the first phalanx, just medial to the insertion of the abductor brevis. Divide the superficial head of the short flexor close to its origin and turn it laterally to its insertion. Trace the tendon of the long flexor to its insertion at the base of the terminal phalanx of the thumb. The small deep head of the flexor pollicis brevis may now be seen; it arises from the lesser multangular bone and runs laterally and distally deep to the tendon of the flexor longus, to be inserted with the superficial head.

The adductor pollicis arises by two heads, which may be clearly distinguished from each other by the fact that the deep volar arch passes medially into the palm between them. The oblique head arises from the capitate and the bases of the second and third metacarpals; the transverse head arises from the volar aspect of the shaft of the third metacarpal. The two heads converge toward a tendon which is inserted into the medial side of the base of the first phalanx of the thumb.

To render the deep volar arch accessible for study, divide the tendons of the flexor digitorum profundus and the flexor pollicis longus at about the level of the distal border of the transverse carpal ligament and turn them forward and distally. The lateral end of the deep volar arch is covered by the oblique head of the adductor pollicis. This, as well as the deep head of the short flexor, should therefore be divided close to its origin, and turned laterally. The deep volar arch begins at the base of the first interosseous

proximally at or near the proximal border of the dorsal carpal ligament and extend distally to about the middle of the dorsum of the hand.

Clean the anconeus. This small triangular muscle arises from the back of the lateral epicondyle of the humerus and spreads distally and medially

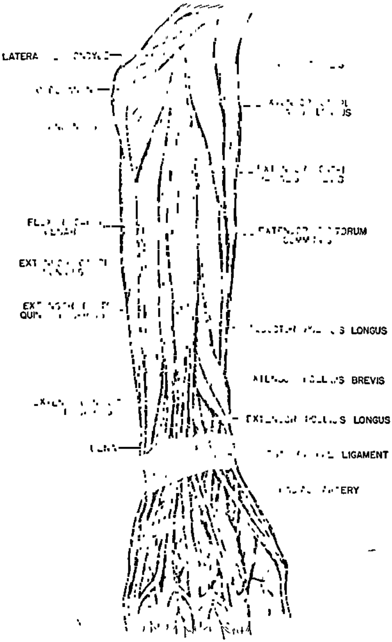

Fig. 64.—Superficial dissection of the dorsum of the forearm and hand.

to be inserted on the lateral border of the olecranon. It is usually more or less continuous superiorly with the medial head of the triceps; its nerve of supply is derived from one of the branches of the radial nerve which supplies the medial head of the triceps.

the medial sides of the bases of the first phalanges of the middle and ring fingers.

Remove any superficial fascia which may remain on the dorsum of the forearm and hand. Observe that the deep fascia on the dorsal aspect of the forearm is more dense than is the deep fascia on the volar aspect. Proximally it forms an aponeurotic sheet from the deep surface of which the superficial extensor muscles take partial origin. At the distal end of the forearm it is strengthened by a strong transverse fibrous band known as the dorsal carpal ligament, whose limits should now be defined. Laterally the dorsal carpal ligament is attached to the lateral border of the distal end of the radius; medially it is bound to the styloid process of the ulna and the triquetral and pisiform bones. In addition to its lateral and medial attachments, the dorsal carpal ligament is firmly attached to a series of bony ridges on the dorsal aspect of the distal ends of the radius and ulna. There are thus formed, deep to the ligament, six osteo-fibrous canals, or compartments, through which the extensor tendons pass to the dorsum of the hand. Identify those various compartments and the tendons which traverse them. (Fig. 64.)

The most lateral compartment is in relation to the lateral surface of the styloid process of the radius; through it pass the tendons of the abductor pollicis longus and the extensor pollicis brevis. Just medial to this is a broad compartment for the tendons of the extensor carpi radialis longus and the extensor carpi radialis brevis. The third compartment is a narrow one for the slender tendon of the extensor pollicis longus. Medial to this is a much wider compartment through which pass the four tendons of the extensor digitorum communis and the tendon of the extensor indicis proprius. The fifth compartment lies over the groove between the radius and the ulna and transmits the tendon of the extensor digiti quinti proprius. The sixth compartment is in relation to the dorsal surface of the ulna, just lateral to the styloid process, and transmits the tendon of the extensor carpi ulnaris.

Explore with a blunt probe the limits of the mucous sheaths which surround the tendons as they pass deep to the dorsal carpal ligament. Each tendon has its own mucous sheath, with the exception that a single sheath encloses the four tendons of the extensor digitorum communis and the tendon of the extensor indicis proprius. The mucous sheaths begin

each extensor tendon receives on its lateral side the tendon of insertion of a lumbrical muscle. It should be noted further that while the main insertion of the interossei is directly into the bases of the first phalanges, each interosseous muscle gives a fibrous expansion to the corresponding extensor tendon; and that the adjacent tendons of the extensor digitorum communis are usually united by oblique fibrous bands on the dorsum of the hand.

The extensor carpi ulnaris has an accessory origin from the proximal part of the dorsal border of the ulna. Its tendon passes deep to the most medial part of the dorsal carpal ligament and is inserted on the base of the fifth metacarpal.

Divide the tendons of the extensor digitorum communis, the extensor digiti quinti proprius, and the extensor carpi ulnaris about half an inch proximal to the dorsal carpal ligament. Detach the ulnar head of the extensor carpi ulnaris from its origin and reflect the superficial group laterally, to expose the deep muscles. As this is done, clean and preserve the nerve twigs which enter the deep surfaces of the muscles in the proximal part of the forearm. The deep group of muscles on the dorsum of the forearm includes the supinator, the abductor pollicis longus, the extensor pollicis brevis, the extensor pollicis longus, and the extensor indicis proprius. In the interval between the superficial and the deep extensors, the dorsal interosseous artery and nerve and their branches will be found. These should therefore be cleaned as the deep muscles are cleaned.

The supinator is partly covered by the anconeus, which may be removed. The supinator arises in part from the common tendon on the lateral epicondyle, but has a more extensive ulnar origin, from the area just below the radial notch and from the supinator crest. Its fibres form a muscular sheet, which wraps laterally around the proximal part of the radius, to be inserted on the volar surface of that bone, from the tuberosity to the insertion of the pronator teres. The deep radial nerve has been seen to enter the supinator in the cubital fossa. Its continuation may now be found, emerging from the distal part of the muscle at the back of the forearm. As it passes through the supinator, the deep radial nerve supplies that muscle; distal to its point of emergence from the supinator, the nerve is known as the dorsal interosseous nerve.

The abductor pollicis longus arises from the proximal part of the middle thirds of the dorsal surfaces of both the radius and the ulna, and the interven-

Retaining the dorsal carpal ligament for the present, clean the muscles of the superficial layer on the dorsal aspect of the forearm. Of these the extensor carpi radialis longus is the most lateral. It arises from the distal portion of the lateral supracondylar ridge of the humerus, and is partially overlapped near its origin by the brachioradialis. The remaining muscles of the superficial layer arise by a common tendon from the lateral epicondyle and from the deep fascia which covers them; they spread distally and medially over the dorsal aspect of the forearm. They are, in order from the lateral to the medial side, the extensor carpi radialis brevis, the extensor digitorum communis, the extensor digiti quinti proprius, and the extensor carpi ulnaris.

The extensores carpi radiales longus and brevis descend along the lateral side of the forearm, the tendon of the former partially covering that of the latter. Just proximal to the dorsal carpal ligament they are crossed superficially by two of the deeper dorsal muscles, the abductor pollicis longus and the extensor pollicis brevis. The tendons of the two radial extensors pass deep to the dorsal carpal ligament as previously noted. Just distal to the ligament they are crossed superficially by the tendon of the extensor pollicis longus. The extensor carpi radialis longus is inserted into the dorsal aspect of the base of the second metacarpal; the extensor carpi radialis brevis into the adjacent portions of the bases of the second and third metacarpals. The two radial extensors are supplied by branches which arise from the radial nerve just proximal to its termination, or from the deep radial before it enters the substance of the supinator.

The extensor digitorum communis gives rise, some distance above the wrist, to four tendons, which pass deep to the dorsal carpal ligament side by side and diverge on the dorsum of the hand toward the backs of the fingers. Opposite the metacarpo-phalangeal joint each tendon gives off a fibrous expansion which is attached to the base of the first phalanx. On the dorsum of the first phalanx each tendon divides into three slips. Of these the middle slip is inserted on the base of the second phalanx, while the two collateral slips pass distally to be inserted together into the base of the terminal phalanx. The tendon of the extensor digiti quinti proprius passes deep to the dorsal carpal ligament in its own compartment, and at the back of the fifth metacarpo-phalangeal joint joins the fourth tendon of the extensor digitorum communis. At about the middle of the first phalanx

the wrist joint, are found in connection with the carpal bones. These may be investigated by dividing the ligaments which bind the dorsal surfaces of the bones together, and spreading the bones apart to expose the articular surfaces. A single large cavity includes the articulations of the navicular, lunate, and triquetral with each other and with the four bones of the distal row, and is further prolonged along both sides of the lesser multangular to include the articulations between the second and third metacarpals and the capitate and lesser multangular. A separate articular cavity is found at the junction of the greater multangular and the first metacarpal. A third cavity is for the articulation of the fourth and fifth metacarpals with the hamate. The fourth is a small cavity between the pisiform and the triquetral.

THE INFERIOR EXTREMITY

Before the skin is reflected from the thigh, attention should be directed to the surface anatomy of the part. Anteriorly the thigh is marked off from the anterior abdominal wall by a depressed line running from the anterior superior iliac spine to the pubic tubercle and corresponding to the line of the inguinal ligament. The gluteal region or buttock, which forms the upper lateral and posterior portion of the inferior extremity, is bounded above by the iliac crest; the prominence of the buttock is caused principally by the gluteus maximus muscle. Medially the thigh is separated from the perineum by the border of the ischio-pubic rami. The head and shaft of the femur are for the most part deeply placed, covered by thick layers of muscle, which give the thigh its rounded contour. The lateral surface of the greater trochanter, however, is subcutaneous. It lies two or three inches below the anterior superior iliac spine and usually projects slightly farther laterally than the most lateral portion of the iliac crest. At the front of the knee the anterior surface of the patella is subcutaneous. At the lateral side of the knee the lateral condyle of the femur may be palpated; immediately below it is the lateral condyle of the tibia and the head of the fibula. At the medial side of the knee, locate the medial condyle of the femur and the medial condyle of the tibia.

The skin should be reflected from the buttock and the entire thigh in a single piece, which will be left attached to the inferior extremity at the lower part of the back of the knee, so that it may be wrapped around the thigh

processes of the ulna. The radial collateral ligament arises from the lateral epicondyle. Its fibres pass distally and most of them end by joining the lateral part of the annular ligament; some fibres, however, are prolonged as far as the neck of the radius. The annular ligament is the proper ligament of the proximal radioulnar joint. It is a strong fibrous band, whose two ends are attached to the anterior and posterior margins of the radial notch of the ulna. It encircles the head of the radius and holds the latter in place as it rotates against the radial notch, in the actions of pronation and supination. The annular ligament may be seen to better advantage if the joint capsule is opened by a transverse incision across its anterior portion. Observe that the bony articular surfaces are covered by a layer of cartilage, and that the articular cavity is elsewhere lined by the synovial membrane.

Clean the fibrous capsules of the distal radioulnar joint and the wrist joint. At the distal radioulnar joint the distal end of the ulna articulates with the ulnar notch on the radius and with the proximal surface of the radial articular disc. Its external ligaments are the volar and dorsal radio-ulnar ligaments, which connect the distal ends of the two bones. At the wrist joint (articulatio radiocarpea) the distal surfaces of the radius and of the radial articular disc articulate with the proximal surfaces of the navicular, lunate, and triquetral bones. Its external ligaments are the radial and ulnar collateral ligaments of the wrist, and the volar and dorsal radiocarpal ligaments. The ulnar collateral ligament is a strong fibrous cord, which descends from the styloid process of the ulna to the pisiform and triquetral bones. The radial collateral ligament consists of fibres which radiate from the tip of the styloid process of the radius to the navicular and greater multangular bones. The dorsal and volar radiocarpal ligaments are thickened parts of the capsule, which spread distally from the lateral part of the distal end of the radius to the dorsal and volar surfaces of the carpal bones. Open the joint by a transverse incision across the anterior part of the capsule and study the articular surfaces. The articular disc is a plate of fibro-cartilage, which is attached laterally to the medial border of the radial articular surface and medially to the styloid process of the ulna. It articulates distally with the triquetral bone and separates the cavity of the wrist joint from that of the distal radioulnar joint.

The carpal bones are joined to one another by dorsal, volar, and inter-osseous ligaments. Four separate articular cavities, in addition to that of

many cases the fine lymphatic vessels which communicate with them may be made out.

Attention should next be directed to the cutaneous nerves of the thigh. The main trunks or branches of these nerves pierce the fascia lata at variable distances below the inguinal ligament or the iliac crest and descend along the deep surface of the superficial fascia. As they are displayed the superficial fascia should be removed.

The lateral femoral cutaneous nerve is a branch of the lumbar plexus. It enters the thigh by passing behind the lateral end of the inguinal ligament. Below the inguinal ligament it divides into an anterior and a posterior branch, which will be found piercing the fascia lata separately. The posterior branch supplies the skin on the upper lateral part of the thigh. The anterior branch becomes superficial somewhat lower and more anteriorly and supplies the skin of the lower lateral part of the thigh.

The lumboinguinal nerve is one of the terminal branches of the genitofemoral nerve. It may emerge through the fossa ovalis or may pierce the fascia lata near that opening. It supplies a variable area of skin below the inguinal ligament on the upper anterior aspect of the thigh.

The intermediate femoral cutaneous nerve and the medial femoral cutaneous nerve are the anterior cutaneous branches of the femoral nerve. Their origin from the femoral nerve will be seen in the dissection of the femoral triangle. At present their terminal branches should be found piercing the fascia lata and traced downward on the thigh. Each usually divides into two branches before piercing the fascia lata. The medial and lateral branches of the intermediate nerve will be found piercing the fascia lata close together at the middle of the anterior aspect of the thigh about a third of the distance between the inguinal ligament and the knee. The branches of the medial cutaneous nerve usually appear close to the great saphenous vein. Small branches of this nerve may be found piercing the fascia lata at any point along the course of the vein; its larger terminal anterior and posterior branches become cutaneous in the lower part of the thigh, the former lying in front of the vein and the latter behind it.

The infrapatellar branch of the saphenous nerve is a cutaneous nerve which becomes superficial at the medial side of the knee, from which point it takes a curved course downward and forward below the patella.

when the part is not in use. Make a longitudinal incision through the skin, downward along the medial aspect of the thigh, from the lower border of the pubic symphysis to the medial condyle of the tibia. From the lower end of this incision carry a transverse incision across the front of the leg, about an inch below the patella, to the head of the fibula. Starting at the upper end of the longitudinal incision, reflect the skin laterally from the entire anterior aspect of the thigh; then continue the reflection of skin posteriorly and downward from the buttock and the posterior aspect of the thigh, leaving the single large skin flap thus reflected attached only at the lower part of the back of the knee, where it is still continuous with the skin on the back of the leg.*

The superficial fascia of the thigh is usually moderately thick and exhibits the typical characteristics of the panniculus adiposus. Within it are numerous superficial veins. The largest and most constant of these is the great saphenous vein, which should now be cleaned. This vein begins on the dorsum of the foot. Ascending on the medial side of the leg, it will be found entering the region at present under observation behind the medial side of the knee. It passes upward along the medial side of the thigh, inclining somewhat forward, and joins the femoral vein about an inch below the inguinal ligament, by passing through the fossa ovalis. This is an oval opening in the deep fascia (fascia lata) of the thigh, which lies immediately in front of the femoral vein, below the medial part of the inguinal ligament.

Observe the superficial inguinal lymph-nodes. These are from ten to twenty in number and often of considerable size. They lie in the superficial fascia below the inguinal ligament in the region of the fossa ovalis. In

* The order of dissection followed here presupposes that the abdomen and pelvis have already been dissected, and the pelvis separated from the vertebral column and split into two parts. If it is desired to dissect the extremity while the abdomen is still intact, it is

258–259 and 262–264) and then pass directly to the dissection of the femoral triangle, the femoral artery, the quadriceps femoris, and the adductor muscles (pages 265–273). The body may then be turned over and the skin reflected from the remainder of the thigh. The cleaning of the superficial muscles of this area (pages 260–262 and 264–265) may then be followed directly by the dissection of the gluteal region, the popliteal fossa, and the deeper structures at the back of the thigh (pages 273–284) The body should then be returned to the supine position, for study of the hip-joint (pages 284–286), after which the extremity will be freed from the trunk and no further alteration of the order here given is necessary.

of the fibres of the gluteus maximus. The external surfaces of these two muscles should now be cleared to demonstrate their relation to the fascia lata.

The tensor fasciae latae is a flat quadrilateral muscle which arises from the anterior portion of the external lip of the iliac crest and the anterior

FIG. 65.—Superficial dissection of the posterior aspect of the thigh.

superior iliac spine. Its fibres run downward and somewhat laterally to join the iliotibial tract about one third of the distance down the thigh.

The gluteus maximus is a large thick quadrangular muscle, made up of very coarse fasciculi. It arises from the most posterior part of the iliac crest and the dorsum of the ilium behind the posterior gluteal line, from

The cutaneous nerves of the gluteal region include the lateral cutaneous branch of the iliohypogastric nerve and a group of small nerves known as the cluneal nerves. They are small and usually difficult to demonstrate but an attempt at their identification should be made as the superficial fascia is removed from the region below the iliac crest.

The lateral cutaneous branch of the iliohypogastric nerve runs downward over the iliac crest at about the junction of its anterior and middle thirds and is distributed to the skin over the outer surface of the anterior part of the ilium. The superior cluneal nerves are the lateral branches of the posterior rami of the first three lumbar nerves. They cross the iliac crest in series behind the lateral cutaneous branch of the iliohypogastric nerve and are distributed to the skin of the gluteal region. The middle cluneal nerves are small nerves derived from the lateral branches of the posterior rami of the first three sacral nerves. They pierce the gluteus maximus in a line running from the posterior superior iliac spine to the tip of the coccyx to supply the skin over the medial part of the gluteus maximus. The inferior cluneal nerves are branches of the posterior femoral cutaneous nerve, which supplies the skin on the posterior aspect of the thigh. They may be most easily identified when the gluteus maximus is cleaned.

The superficial fascia should now be entirely removed from the anterior and lateral aspects of the thigh, to expose the deep fascia. Retain only enough of the medial and intermediate femoral cutaneous nerves so that their origin from the femoral nerve may later be recognized. The deep fascia which invests the thigh is known as the fascia lata. Superiorly it is attached to the inguinal ligament and the iliac crest. Toward the medial aspect of the thigh the fascia lata is relatively thin and does not differ appreciably from the deep fascia which is ordinarily found investing muscles. Along the lateral aspect of the thigh, however, it is resolved into a very dense aponeurotic band known as the iliotibial tract, which should now be investigated.

The external surface of the iliotibial tract of the fascia lata will have been exposed by the removal of the superficial fascia. Superiorly it is attached to the anterior part of the iliac crest, through the fascia covering the gluteus medius muscle. Inferiorly it extends over the lateral side of the knee joint to be attached to the lateral condyle of the tibia. The iliotibial tract receives the insertions of the tensor muscle of the fascia lata and most

medial side of the knee; from here the muscle is continued downward as a flat tendon which is inserted into the upper part of the medial surface of tibia. This insertion will be seen later in the dissection.

The anterior and lateral portions of the thigh, below and lateral to the sartorius, are occupied by the four muscles which make up the quadriceps femoris; these are the rectus femoris and the vastus medialis, vastus intermedius, and vastus lateralis.

The uppermost portion of the rectus femoris is overlapped by the sartorius medially and the tensor fasciae latae laterally. It arises from the coxal bone by two separate short tendons, which will be seen to better advantage somewhat later. The "straight" tendon arises from the anterior inferior iliac spine, the "reflected" tendon from the upper surface of the rim of the acetabulum. The two tendons unite to form an aponeurotic expansion, whose anterior surface may now be seen in the interval between the upper part of the sartorius and the tensor fasciae. Observe that muscle fibres spread downward from this aponeurosis to form a thick spindle-shaped muscle on the front of the thigh, which is inserted by a strong flat tendon into the upper border of the patella.

In the roughly triangular interval between the lower parts of the sartorius and the rectus, clean the exposed portion of the vastus medialis. The origin of this muscle from the medial lip of the linea aspera will be seen later; its insertion into the lower part of the tendon of insertion of the rectus and the medial border of the patella is now visible.

A little dissection in the narrow interval just above the medial side of the knee between the inferior border of the vastus medialis and the anterior border of the sartorius will expose a strong rounded tendon which is inserted into the adductor tubercle on the upper surface of the medial condyle of the femur. This tendon represents the lowest portion of the insertion of the adductor magnus muscle.

Lateral to the rectus femoris, clean the exposed portion of the vastus lateralis. Draw the iliotibial tract laterally and observe that it lies immediately external to the broad lateral surface of the vastus lateralis. Pass the hand posteriorly on the internal surface of the fascia lata, in the interval between the fascia and the vastus lateralis, and observe that a short fascial septum extends inward from the deep surface of the postero-lateral portion of the fascia lata to the lateral lip of the linea aspera and the lateral supra-

the lateral part of the posterior surface of the sacrum and coccyx and from the sacrotuberous ligament. Its fibres pass downward and laterally across the buttock and the greater portion of them are inserted into the iliotibial tract of the fascia lata. When the muscle is reflected at a later stage of the dissection it will be found that the deeper fibres of its more inferior portion are inserted into the gluteal tuberosity of the femur.

The two borders of the gluteus maximus should be carefully defined. Stretching across a roughly triangular area bounded by the superior border of the gluteus maximus, the posterior border of the tensor fasciae, and the iliac crest, the fascia lata covers the external surface of the gluteus medius. This portion of the fascia lata is usually covered by a relatively thick layer of superficial fascia, all of which should be removed. (Fig. 65.)

As the inferior border of the gluteus maximus is cleaned the inferior cluneal branches of the posterior femoral cutaneous nerve will be found turning upward around this border. The trunk of the posterior femoral cutaneous nerve will be found emerging from behind the middle of the lower border of the gluteus maximus to run downward on the posterior aspect of the thigh.

The iliotibial tract is merely a greatly thickened portion of the fascia lata and is continuous with the thinner portion of the fascia stretching medially across the anterior aspect of the thigh. Since the fascia covering the anterior thigh muscles must be removed in cleaning the muscles, and since it is desirable for the present to retain the iliotibial tract, an artificial anterior border for the iliotibial tract may be made by dissection. To do this make a longitudinal incision through the fascia lata running downward from the lower end of the anterior border of the tensor fasciae latae to the lateral condyle of the tibia. The thick portion of the fascia lata behind this incision is the iliotibial tract; the continuation of the fascia lata across the thigh in front of this incision may be removed as the anterior thigh muscles are cleaned. In the preliminary cleaning of the superficial muscles of the thigh, which is to be the next step in the dissection, care should be taken to avoid displacing the muscles. Clean only their external surfaces and keep their relative positions undisturbed.

Clean first the sartorius. This is a long narrow strap-like muscle which crosses the anterior aspect of the thigh obliquely. Arising from the anterior superior spine of the ilium, its fibres run downward and medially to the

lies immediately in front of the semitendinosus and consequently is partially hidden by the latter. In the lower part of the thigh, however, it is considerably wider than the semitendinosus, so that its posterior surface is exposed both medial and lateral to the latter. The medial portion of the semimembranosus lies immediately behind the gracilis; the lower part of its lateral border forms the supero-medial boundary of the popliteal fossa. The flat tendon of insertion of the semimembranosus, whose insertion on the medial condyle of the tibia will be demonstrated later, is covered externally by the tendons of the gracilis and the semitendinosus.

Below the medial part of the gluteus maximus, between the posterior border of the upper part of the gracilis, and the medial border of the semimembranosus, *a small portion of the posterior surface of the adductor magnus* muscle is superficial, and should now be cleaned. (Fig. 65.)

Now return to the anterior aspect of the thigh. The interval on the upper anterior part of the thigh, between the medial border of the sartorius and the anterior border of the gracilis, from which the deep fascia has not yet been removed, is occupied by the muscles of the adductor group. Attention should first be directed to the femoral triangle. This space is bounded above by the inguinal ligament, laterally by the medial border of the upper part of the sartorius, and medially by the medial border of the adductor longus. Its roof or superficial boundary is formed by the fascia lata, which is here relatively thin. Its floor, or deep boundary, is formed by the anterior surfaces of the adductor longus, pectineus, and ilio-psoas muscles. Within the femoral triangle are the upper portions of the femoral vessels and the terminal part of the femoral nerve. Remove the fascia lata from the roof of the femoral triangle, define the medial border of the adductor longus, and study the femoral vessels and the femoral sheath.

The adductor longus arises by a narrow flat tendon from the superior ramus of the pubis near the pubic tubercle. The fibres pass downward and laterally from this origin, as the muscle widens toward its insertion on the middle third of the linea aspera. Its medial border, particularly near the origin, is usually adjacent to the anterior border of the gracilis. (Fig. 66.)

The femoral artery begins behind the inguinal ligament as a direct continuation of the external iliac artery. It descends in the femoral triangle, which it leaves a short distance above the apex of the triangle, by passing behind the sartorius. At its beginning the femoral artery is lateral to the

condylar ridge. This is the lateral intermuscular septum of the thigh, which separates the anterior or extensor group of muscles from the posterior flexor or ham-string muscles. The vastus lateralis arises principally from the lateral lip of the linea aspera, but some of its fibres arise from the anterior surface of the lateral intermuscular septum. The fibres run downward and forward around the lateral side of the thigh to be inserted into the lower part of the rectus tendon and the lateral border of the patella.

Turn next to the medial aspect of the thigh and clean the external surface of the gracilis. This muscle arises by a flat tendon from the margin of the inferior ramus of the pubis and the adjacent part of the inferior ramus of the ischium. Its upper portion is flat and relatively broad. As it descends on the medial aspect of the thigh it becomes narrower and thicker, finally giving rise to a rounded tendon which descends behind the medial condyle of the femur. Its insertion on the medial surface of the tibia will be seen later. In the lower half of the thigh the gracilis lies immediately posterior to the sartorius. (Fig. 66.)

Turn to the back of the thigh and clean the exposed surfaces of the flexor or ham-string muscles. These three muscles, the biceps femoris, semitendinosus, and semimembranosus, will be found emerging from behind the lower border of the gluteus maximus; their origins from the ischial tuberosity are at present hidden by the lower part of that muscle. (Fig. 65.)

The thick fleshy belly of the long head of the biceps will be found below the lateral part of the lower border of the gluteus maximus. Its fibres run downward and somewhat laterally to join a thick flat tendon which passes downward along the lateral side of the back of the knee. The medial border of this tendon forms the supero-lateral boundary of the popliteal fossa, the fat-filled space at the back of the knee. On its lateral side this tendon is joined by the fibres of the short head, which arise from the distal part of the linea aspera near its lateral lip, from the lateral supra-condylar ridge, and from the posterior surface of the lateral intermuscular septum. Observe that the short head of the biceps is separated from the vastus lateralis only by the intermuscular septum.

Below the gluteus maximus medial to the biceps and partly overlapped by it laterally, is the semitendinosus. Its flat belly begins to contract at about the middle of the thigh toward a thick rounded tendon, which passes downward behind the medial condyle of the femur. The semimembranosus

face of the pubis below the pecten; its fibres pass downward and laterally to be inserted into the pectineal line behind and below the lesser trochanter of the femur.

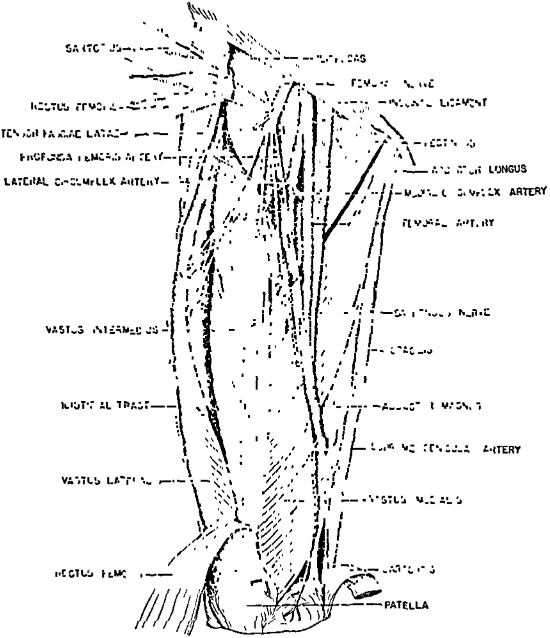

Fig. 66.—Dissection of the anterior aspect of the thigh. The sartorius and rectus femoris have been reflected, and the vastus lateralis and iliotibial tract displaced laterally.

Identify the three large branches which arise from the femoral artery within the femoral triangle. These are the profunda femoris and the medial and lateral femoral circumflex arteries. The profunda arises from the posterior aspect of the femoral about an inch and a half below the inguinal ligament and runs downward through the triangle behind and slightly lateral

femoral vein; lower down it comes to lie in front of the vein. In the uppermost part of the femoral triangle both the artery and the vein are enclosed within the femoral sheath, which should now be investigated.

The femoral sheath is a funnel-shaped fascial sheath which represents a prolongation behind the inguinal ligament into the thigh of portions of the transversalis fascia and the iliac fascia. Its anterior wall is continuous above the inguinal ligament with the transversalis fascia; its posterior wall is continuous with the portion of the iliac fascia which lies behind the external iliac vessels. The lateral boundary of the femoral sheath is formed by the blending of these two layers of fascia around the lateral side of the femoral artery. The femoral sheath can be traced as a distinct structure for only about an inch below the inguinal ligament; lower than this it joins the general fascial covering of the vessels. Its chief importance lies in the fact that its anterior and posterior walls do not blend immediately on the medial side of the femoral vein, but are prolonged farther medially to enclose a loosely-filled compartment of the sheath known as the femoral canal, which lies along the medial side of the uppermost part of the femoral vein, and may be the seat of a femoral hernia.

The upper or abdominal end of the femoral canal is known as the femoral ring. It is here that a femoral hernia leaves the abdominal cavity. The *femoral ring lies behind the medial part of the inguinal ligament.* It is bounded laterally by the femoral vein, medially by the free margin of the lacunar ligament, and posteriorly by the pecten of the pubis. It is loosely filled by fat and a few small lymph glands and consequently forms a weak spot in the abdominal wall.

Clear away the femoral sheath, and without injury to the femoral artery, the femoral nerve and their branches, attempt to define the borders of the muscles which form the floor of the femoral triangle. The adductor longus has already been seen to form the lower medial portion of the floor. The upper lateral portion of the floor of the femoral triangle is formed by the ilio-psoas. This muscle, which here consists of the psoas tendon and the lower fibres of the iliacus, enters the thigh by passing behind the lateral part of the inguinal ligament. Its insertion on the lesser trochanter of the femur is at present hidden by the sartorius. Between the ilio-psoas and the adductor longus the floor of the femoral triangle is formed by the anterior surface of the pectineus. This flat muscle has a fleshy origin from the outer sur-

face of the pubis below the pecten; its fibres pass downward and laterally to be inserted into the pectineal line behind and below the lesser trochanter of the femur.

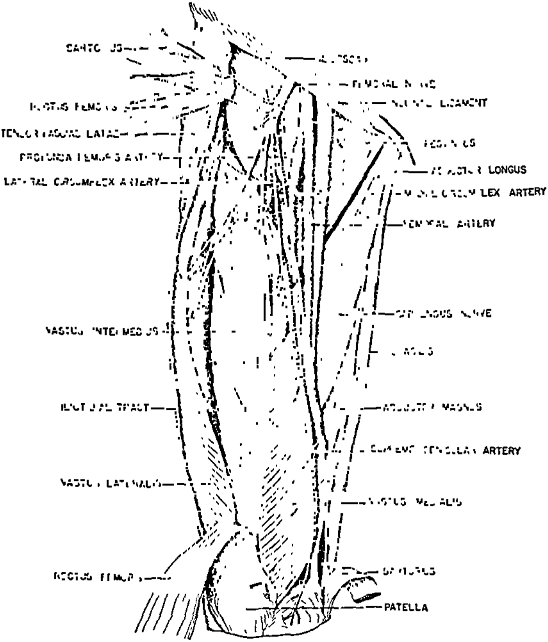

Fig. 66.—Dissection of the anterior aspect of the thigh. The sartorius and rectus femoris have been reflected, and the vastus lateralis and iliotibial tract displaced laterally.

Identify the three large branches which arise from the femoral artery within the femoral triangle. These are the profunda femoris and the medial and lateral femoral circumflex arteries. The profunda arises from the posterior aspect of the femoral about an inch and a half below the inguinal ligament and runs downward through the triangle behind and slightly lateral

to the femoral. The femoral circumflex arteries are somewhat variable in origin. In many cases they appear as branches of the profunda. It is very common, however, to find one or both of them arising as direct branches of the femoral a short distance below the origin of the profunda. The medial femoral circumflex artery passes medially and posteriorly to leave the femoral triangle between the adjacent borders of the psoas and pectineus muscles, first giving rise to a superficial branch to the muscles of the adductor group. The lateral femoral circumflex artery passes laterally behind the sartorius and rectus muscles.

The femoral nerve enters the femoral triangle by passing downward behind the inguinal ligament lateral to the psoas tendon. It ends in the upper part of the triangle by dividing into two groups of terminal branches, an anterior or superficial and a posterior or deep group. The superficial group should now be studied. They include the nerve to the pectineus, the nerve to the sartorius, and the medial and intermediate femoral cutaneous nerves. The nerve to the pectineus passes medially and downward behind the femoral vessels to reach the anterior surface of the pectineus. The nerve to the sartorius often arises in common with the intermediate cutaneous branch, from which it separates before entering the upper part of the sartorius. The distribution of the cutaneous branches has already been studied; the intermediate cutaneous nerve frequently pierces the sartorius before becoming superficial.

As the femoral artery leaves the femoral triangle it enters a space known as the adductor canal. To open this canal for study it will be necessary to reflect the sartorius. Divide this muscle at about its middle by an incision at right angles to the direction of its fibres, and reflect the two segments toward the origin and the insertion of the muscle. The adductor canal is triangular in section, posessing a lateral, a posterior, and an antero-medial wall. The lateral wall is formed by the external surface of the vastus medialis muscle. The posterior wall is formed by portions of the anterior surfaces of the adductor longus and adductor magnus muscles. The canal is covered antero-medially by the sartorius but its antero-medial wall is further reenforced by an aponeurotic septum which bridges across from the adductors to the vastus medialis under cover of the sartorius. Make a longitudinal incision through this aponeurosis to expose the femoral vessels and the saphenous nerve within the canal.

Observe that within the adductor canal the femoral vein lies behind the femoral artery. Posteriorly the vessels rest against the adductor longus in the upper part of the canal and below the medial border of the adductor longus, against the adductor magnus. Observe the tendinous opening in the adductor magnus at the side of the medial supra-condylar ridge of the femur. As it passes through this opening the femoral artery terminates by becoming the popliteal artery; the femoral vein begins here as a direct continuation of the popliteal vein. In the adductor canal the femoral artery is crossed anteriorly by the saphenous nerve. Trace this nerve proximally and observe that it is one of the deep terminal branches of the femoral nerve. Traced distally it does not accompany the femoral vessels through the adductor magnus, but continues downward under cover of the sartorius, to become superficial at the medial side of the knee between the tendons of the sartorius and the gracilis. Its distribution as a cutaneous nerve of the leg will be seen later.

Clean the supreme genicular artery (a. suprema genu). This artery arises from the femoral just above the tendinous opening in the adductor magnus and almost immediately divides into a saphenous and a musculo-articular branch. The two branches frequently arise separately from the femoral. The saphenous branch accompanies the saphenous nerve; the musculo-articular branch enters the vastus medialis, giving twigs to that muscle and taking part in the general arterial anastomosis around the knee-joint.

Now return to the deep group of terminal branches of the femoral nerve. These are the saphenous nerve, which has already been traced, and the nerves to the rectus femoris, the vastus lateralis, the vastus intermedius, and the vastus medialis. Secure first the nerve to the rectus femoris and trace it into the deep surface of that muscle. Then divide the rectus femoris transversely at about its middle and reflect the cut segments toward the origin and the insertion. The reflection of the rectus femoris will expose a portion of the vastus intermedius, and will also facilitate the study of the distribution of the lateral femoral circumflex artery and the nerves to the vasti.

The lateral femoral circumflex artery ends behind the upper part of the rectus femoris by dividing into ascending and descending branches. These should now be cleaned. The ascending branch runs upward and laterally

under cover of the rectus and sartorius, to both of which it gives branches, and ends under cover of the tensor fasciae latae, where it anastomoses with the superior gluteal artery. The descending branches run downward and laterally and provide the main supply of the vastus intermedius and vastus lateralis. The most lateral of these branches, which accompanies the nerve to the vastus lateralis, will serve as a guide to the anterior border of that muscle. (Fig. 66.)

Define the anterior border of the vastus lateralis, raise it from the subjacent vastus intermedius, and study the origins of these two muscles. The lower fibres of the vastus lateralis have already been seen to arise from the lateral lip of the linea aspera and the lateral intermuscular septum. Observe now that its upper fibres arise from the antero-inferior margin of the great trochanter and below this from a line curving downward and laterally around the femur to join the lateral lip of the linea aspera. Its nerve passes under the anterior border of the muscle to reach its deep surface. The vastus intermedius has a broad origin from the lateral and anterior surfaces of the upper two-thirds of the shaft of the femur. Its fibres pass downward and forward to join an aponeurosis which lies on the anterior surface of the muscle and is inserted, in common with the rectus tendon and fibres of the other two vasti into the proximal border of the patella. The nerve to the vastus intermedius enters the upper part of its antero-medial surface.

The vastus medialis arises from the entire length of the medial lip of the linea aspera. It is intimately associated above with the vastus intermedius. Distally its upper fibres join a flat tendon, which overlies the medial margin of the tendon of the vastus intermedius and is difficult to separate from it. If the proper separation is made, however, and the vastus medialis pushed medially, it will be seen that the broad medial surface of the femur is bare of muscle attachments and is simply overlain by the deep surface of the vastus medialis. (Figs. 66 and 71.)

Attention should now be directed to the adductor group of muscles and the nerves and vessels which supply them. Of this group, the superficial surfaces of the gracilis, adductor longus, and pectineus have already been cleaned. If the anterior surfaces of the adductor longus and pectineus have not been completely cleaned this should be done now. At the same time, clean the insertion of the ilio-psoas. Observe that most of the fibres of the iliacus join the psoas tendon, which is inserted into the lesser trochanter,

but that a few of the lowest fibres of the iliacus are inserted directly into the femur in a line extending for a short distance below the lesser trochanter.

The *origin of the profunda femoris artery* has already been cleaned. Trace it distally and observe that it passes downward behind the adductor longus. Detach the adductor longus from its origin and reflect it anteriorly and laterally toward its insertion. At the same time secure and preserve the nerve which enters its deep surface; this is a branch of the obturator nerve. The reflection of the adductor longus will expose the lower part of the adductor brevis muscle, which lies behind the lower part of the pectineus and the upper part of the adductor longus. Define the lower (medial) border of this muscle and then clean and study the full course of the a. profunda femoris. (Fig. 67.)

The profunda lies in the femoral triangle in the first part of its course, resting posteriorly against the iliopsoas and then the pectineus. Passing behind the adductor longus it descends in front of the adductor brevis and finally for a short distance in front of the adductor magnus. It ends as the fourth perforating artery, which pierces the adductor magnus close to the femur, to reach the hamstring muscles. From its posterior aspect the profunda gives rise to a series of perforating arteries, which pass posteriorly through the adductor muscles to reach the back of the thigh. The first perforating artery arises at about the level of the upper border of the adductor longus, and pierces both the adductor brevis and the adductor magnus. The second perforating artery arises somewhat lower and also pierces both of these muscles. The third perforating artery passes below the adductor brevis, piercing only the magnus. The fourth perforating artery is the termination of the profunda itself. From the medial aspect of the profunda one or two small branches are given to the adductor muscles.

Detach the pectineus from its origin and reflect it anteriorly and laterally to its insertion. Then, by tracing proximally the nerve to the adductor longus previously identified, find the anterior division of the obturator nerve. This nerve descends under cover of the pectineus, where it divides into three branches, which may now be traced into the adductor longus, the adductor brevis, and the gracilis.

Clean the anterior surface of the adductor brevis. This muscle has a narrow origin from the outer surface of the inferior ramus of the pubis under cover of the origins of the pectineus and adductor longus. The fibres diverge

laterally to form a flat triangular muscle which is inserted into the upper part of the linea aspera immediately lateral to the insertions of the pectineus and adductor longus. Define clearly the upper border of the adductor brevis and observe that the uppermost portion of the adductor magnus is exposed above it. Running downward on the anterior surface of the adductor magnus to disappear behind the adductor brevis is the posterior division of the obturator nerve. Above the upper border of the adductor magnus the upper part of the external surface of the obturator externus muscle,

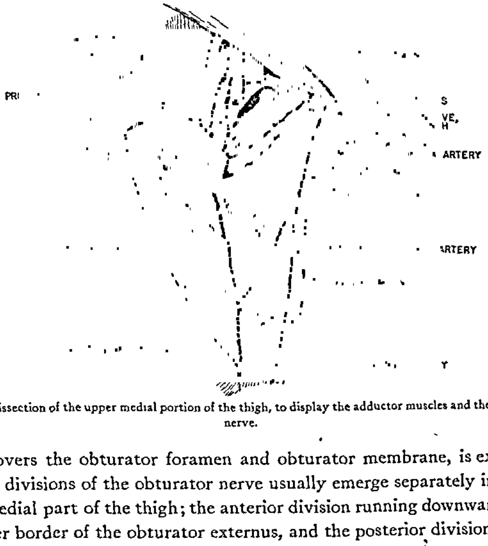

FIG 67.—Dissection of the upper medial portion of the thigh, to display the adductor muscles and the obturator nerve.

which covers the obturator foramen and obturator membrane, is exposed. The two divisions of the obturator nerve usually emerge separately into the upper medial part of the thigh; the anterior division running downward over the upper border of the obturator externus, and the posterior division piercing that muscle slightly below its superior border. (Fig. 67.)

Cut the nerve to the gracilis, and detach the adductor brevis from its origin and reflect it anteriorly and laterally to its insertion. Then study the anterior surface of the adductor magnus. This muscle has a long origin beginning on the inferior ramus of the pubis and running backward along the outer surface of the ischium to the tuberosity. It has a very extensive

linear insertion on the entire length of the linea aspera, and the medial supracondylar ridge. This insertion is broken at the tendinous opening already observed, through which the femoral vessels leave the front of the thigh. The most distal part of the insertion of the adductor magnus is by means of a strong rounded tendon which joins the adductor tubercle.

Running downward on the anterior surface of the adductor magnus and supplying it, is the posterior division of the obturator nerve. This nerve also gives rise to a long slender twig which pierces the lower part of the adductor magnus to reach the knee-joint.

The medial femoral circumflex artery has already been seen to leave the femoral triangle by passing between the psoas and the pectineus. It may now be seen to proceed farther toward the back of the thigh above the upper border of the adductor magnus, between that muscle and the obturator externus.

The external surface of the gluteus maximus muscle has already been cleaned. Clearly define the entire length of both its upper and lower borders if this was not previously done. Then make an incision through the entire thickness of the muscle, taking care to avoid injury to underlying structures. This incision should start at about the middle of the upper border and run vertically downward, to the lower border. Then reflect the lateral cut segment of the muscle to its insertion. Observe that while the muscle is for the most part inserted into the iliotibial tract, the deeper fibres of its inferior portion are inserted directly into the gluteal tuberosity of the femur. Between the deep surface of the muscle and the greater trochanter a closed mucous bursa, sometimes very large, is usually found. Next reflect the medial segment of the muscle to its origin. As this is done clean and preserve the inferior gluteal nerve and the branches of the superior and inferior gluteal arteries, which ramify on the deep surface of the gluteus maximus and supply it. Observe that some of the lower fibres of the muscle take origin from the outer surface of the sacrotuberous ligament; these fibres should be detached and the ligament cleaned. (Fig. 68.)

The sacrotuberous ligament, which runs downward and laterally from the sacrum and coccyx to the ischial tuberosity, forms the infero-medial boundary of the lesser sciatic foramen, the passage by which the gluteal region communicates with the ischio-rectal fossa of the perineum. Both this foramen and the greater sciatic foramen above it, by which the pelvic

cavity is put into communication with the gluteal region, are covered externally by the gluteus maximus. Attention should next be given to the various structures which emerge from the pelvis through the greater sciatic foramen. These structures are the piriformis muscle, the superior gluteal, inferior gluteal, and internal pudendal vessels, and the sciatic, posterior femoral cutaneous, superior and inferior gluteal, and pudendal nerves, the nerve to the quadratus femoris, and the nerve to the obturator internus; all of these nerves are derived from the sacral plexus.

Clean first the piriformis. This small muscle arises within the pelvis from the lateral part of the sacrum, and also to some extent from the upper border of the greater sciatic notch. Emerging from the greater sciatic foramen, its fibres run downward and laterally, narrowing to a round tendon which is inserted upon the highest part of the great trochanter of the femur. In some cases the fleshy belly of the muscle is divided by the passage through it of the common peroneal nerve. (This nerve, which is normally one of the terminal branches of the sciatic nerve, does not in most cases appear in the gluteal region at all. Fairly frequently, however, the sciatic nerve as a whole is lacking, its two terminal branches, the tibial and common peroneal nerves, arising directly from the sacral plexus. In such cases the common peroneal nerve usually pierces the piriformis, the tibial nerve passing below it.)

The superior gluteal nerve and artery emerge through the greater sciatic foramen immediately above the piriformis. Only a small segment of the superior gluteal nerve may be seen at present, since it disappears almost at once under cover of the posterior border of the gluteus medius. The superior gluteal artery lies above the nerve. It gives several large branches to the upper part of the gluteus maximus and then accompanies the nerve under cover of the gluteus medius.

The inferior gluteal nerve and vessels emerge immediately below the piriformis. The inferior gluteal nerve is distributed entirely to the gluteus maximus. The inferior gluteal artery breaks up into numerous branches, the largest of which enter the gluteus maximus. Others pass downward and laterally to take part in the general arterial anastomosis around the greater trochanter, while one long slender branch accompanies the sciatic nerve downward into the thigh.

The sciatic nerve is the largest nerve in the body. It appears below the piriformis and runs somewhat laterally and downward into the thigh, to

pass from view under cover of the long head of the biceps femoris. No branches arise from it in the gluteal region. Occasionally, as noted above, it is represented by two nerves, the tibial and the common peroneal; of these the common peroneal is the more lateral.

The distribution of the posterior femoral cutaneous nerve to the skin on the buttock and the back of the thigh has already been observed. It emerges from the greater sciatic foramen below the piriformis and passes

FIG 68.—Dissection of the gluteal region.

downward, lying at first under cover of the gluteus maximus in close relation to the sciatic nerve. The remaining structures which pass through the greater sciatic foramen will also be found below the piriformis. Before exposing them, however, it is advisable to identify and clean the tendon of the obturator internus, the gemelli muscles, and the quadratus femoris.

The obturator internus has a wide origin on the internal wall of the pelvis minor from the inner surface of the coxal bone and the obturator membrane. Its fibres converge toward the lesser sciatic notch to join a flat tendon which curves laterally across the notch and extends laterally and upward in front of the sciatic nerve to be inserted into the trochanteric fossa on the greater

cavity is put into communication with the gluteal region, are covered externally by the gluteus maximus. Attention should next be given to the various structures which emerge from the pelvis through the greater sciatic foramen. These structures are the piriformis muscle, the superior gluteal, inferior gluteal, and internal pudendal vessels, and the sciatic, posterior femoral cutaneous, superior and inferior gluteal, and pudendal nerves, the nerve to the quadratus femoris, and the nerve to the obturator internus; all of these nerves are derived from the sacral plexus.

Clean first the piriformis. This small muscle arises within the pelvis from the lateral part of the sacrum, and also to some extent from the upper border of the greater sciatic notch. Emerging from the greater sciatic foramen, its fibres run downward and laterally, narrowing to a round tendon which is inserted upon the highest part of the great trochanter of the femur. In some cases the fleshy belly of the muscle is divided by the passage through it of the common peroneal nerve. (This nerve, which is normally one of the terminal branches of the sciatic nerve, does not in most cases appear in the gluteal region at all. Fairly frequently, however, the sciatic nerve as a whole is lacking, its two terminal branches, the tibial and common peroneal nerves, arising directly from the sacral plexus. In such cases the common peroneal nerve usually pierces the piriformis, the tibial nerve passing below it.)

The superior gluteal nerve and artery emerge through the greater sciatic foramen immediately above the piriformis. Only a small segment of the superior gluteal nerve may be seen at present, since it disappears almost at once under cover of the posterior border of the gluteus medius. The superior gluteal artery lies above the nerve. It gives several large branches to the upper part of the gluteus maximus and then accompanies the nerve under cover of the gluteus medius.

The inferior gluteal nerve and vessels emerge immediately below the piriformis. The inferior gluteal nerve is distributed entirely to the gluteus maximus. The inferior gluteal artery breaks up into numerous branches, the largest of which enter the gluteus maximus. Others pass downward and laterally to take part in the general arterial anastomosis around the greater trochanter, while one long slender branch accompanies the sciatic nerve downward into the thigh.

The sciatic nerve is the largest nerve in the body. It appears below the piriformis and runs somewhat laterally and downward into the thigh, to

a broad flat tendon which is inserted on the external surface of the great trochanter in a diagonal line running from the postero-superior to the antero-inferior angle of the trochanter. At its insertion this tendon is usually more or less intimately connected with the tendon of origin of the uppermost part of the vastus lateralis. Carefully define the posterior border of the gluteus medius, and observe that while the gluteus minimus lies for the most part under cover of the gluteus medius, a small portion of it is exposed behind and below the posterior border of the medius. To expose the gluteus minimus, the gluteus medius should now be carefully detached from its origin and turned downward and laterally to its insertion. As this is done observe the the twigs of supply which enter its deep surface from the superior gluteal nerve.

Clean and study the gluteus minimus; the superior gluteal nerve and artery should be cleaned at the same time. The gluteus minimus arises from the outer surface of the ilium between the anterior and inferior gluteal lines; at the upper anterior part it is often partially blended with the gluteus medius. Its fibres converge downward and laterally to a tendon which is inserted on the anterior border of the great trochanter. (Fig. 70.)

The superior gluteal nerve has already been seen to emerge from the greater sciatic foramen and pass laterally under cover of the gluteus medius. Here it divides almost immediately into a superior and an inferior branch. The superior branch goes forward along the upper border of the gluteus minimus and is distributed entirely to the gluteus medius; the inferior branch crosses the middle of the gluteus minimus, gives twigs of supply to both the medius and the minimus, and ends anteriorly in the deep surface of the tensor fasciae latae, which it also supplies. The superficial branches of the superior gluteal artery which enter the gluteus maximus, have already been seen; its deeper continuation divides into two branches which are distributed with the two branches of the superior gluteal nerve. The inferior branch anastomoses with the ascending branch of the lateral femoral circumflex artery, under cover of the tensor fasciae latae.

Now turn to the interior of the pelvis and study the sacral plexus. This plexus, part of which is often separately described as the pudendal plexus, lies in front of the lateral part of the sacrum and the origin of the piriformis, and external to the parietal pelvic fascia, which must be removed for its display. The roots of the plexus are the lumbosacral trunk and the anterior

trochanter of the femur. This tendon is overlapped above by the gemellus superior and below by the gemellus inferior.

The gemelli are two small muscles which are inserted together with the obturator internus and intimately connected with its tendon throughout. The gemellus superior arises from the outer surface of the spine of the ischium. The gemellus inferior arises from the upper part of the ischial tuberosity and the sacrotuberous ligament near the tuberosity.

The quadratus femoris lies below the gemellus inferior. It arises from the outer border of the ischial tuberosity. Its fibres pass almost directly laterally to be inserted into a vertical ridge on the femur immediately below the posterior border of the great trochanter. (Fig. 68.)

The nerve to the quadratus femoris, the nerve to the obturator internus, the internal pudendal vessels, and the pudendal nerve, all of which emerge from the pelvis through the greater sciatic foramen below the piriformis, will be found running downward across the outer surface of the ischium in the roughly triangular space bounded by the sacrotuberous ligament, the gemellus superior, and the sciatic nerve. Most medial is the pudendal nerve. This nerve runs downward and somewhat medially across the outer surface of the ischial spine and passes through the lesser sciatic foramen to enter Alcock's canal on the lateral wall of the ischiorectal fossa. Immediately lateral to it is the internal pudendal artery, which follows a similar course. In some cases the inferior haemorrhoidal nerve, which is usually a branch of the pudendal, arises separately from the sacral plexus, and so will also be found, accompanying the pudendal. The nerve to the obturator internus crosses the ischium lateral to the internal pudendal artery. It gives a branch of supply to the gemellus superior and then passes through the lesser sciatic foramen to enter the deep surface of the obturator internus. The nerve to the quadratus femoris is still farther lateral and often overlapped externally by the sciatic nerve. It passes downward, anterior to the obturator tendon and the gemelli, gives a branch of supply to the gemellus inferior, and enters the deep (anterior) surface of the quadratus femoris.

Clean and study the gluteus medius. This muscle, which is only partly covered by the gluteus maximus, arises from the outer lip of the iliac crest, the external surface of the ilium between the anterior and posterior gluteal lines, and the deep surface of the portion of the fascia lata which covers it externally above the gluteus maximus. Its fibres converge downward to

be done now, the skin being removed as far inferiorly as the level of the neck of the fibula.

The popliteal fossa is the diamond-shaped space which lies at the back of the knee. Its highest point or apex is the point at which the biceps and semimembranosus muscles separate from each other. Its supero-lateral boundary is formed by the medial border of the biceps; its supero-medial boundary by the lateral border of the semimembranosus. Its infero-lateral and infero-medial boundaries are formed by the lateral and medial heads of the gastrocnemius muscle, which arise from the lateral and medial condyles of the femur under cover of the biceps and semimembranosus respectively. The roof or superficial boundary of the fossa is formed merely by skin and fascia; its floor or deep boundary is formed from above downward by the popliteal surface of the femur, the oblique popliteal ligament at the back of the knee-joint, and the fascia covering the popliteus muscle. The fossa itself is filled with fatty areolar tissue, which must be removed as the dissection proceeds, to expose the other structures contained. These are the popliteal artery and its branches, the popliteal vein and its tributaries, portions of the tibial and common peroneal nerves and some of their branches, and the upper part of the plantaris muscle. (Fig. 69. See also Fig. 65.)

Clean first the terminal part of the small saphenous vein. This vein ascends in the superficial fascia on the middle of the calf, to enter the popliteal fossa at about its middle and terminate in the popliteal vein. Just lateral to it, but on a slightly deeper plane, is the medial sural cutaneous nerve, which arises from the tibial nerve in the upper part of the popliteal fossa and descends on the external surface of the gastrocnemius. Identify the common peroneal nerve. This nerve and the tibial nerve are the two terminal branches of the sciatic nerve. They arise from the sciatic usually under cover of the biceps, but occasionally not until the apex of the popliteal fossa is reached. The common peroneal is at its origin lateral to the tibial. It passes downward and laterally, close to the medial margin of the biceps, and leaves the popliteal fossa by crossing the external surface of the lateral head of the gastrocnemius, still closely following the border of the biceps. It gives rise to one or two small articular branches, which pass deeply into the fossa to reach the knee-joint, and the lateral sural cutaneous nerve, which descends on the lateral head of the gastrocnemius. Now clean the upper portions of the two heads of the gastrocnemius muscle, from which the skin

rami of the first four sacral nerves. The lumbosacral trunk is formed by the junction of a branch of the fourth lumbar with the entire anterior ramus of the fifth lumbar nerve. The trunk descends behind the common iliac artery into the pelvis and unites with the first sacral to form a loop through which the superior gluteal artery usually passes. This loop joins with the anterior rami of the second and third and part of the fourth sacrals to form a flattened nervous mass which is the sacral plexus. Passing downward in front of the origin of the piriformis muscle the plexus becomes resolved into two bands, a very large upper and lateral sciatic band and a much smaller lower and medial pudendal band. Passing between the adjacent borders of the coccygeus and piriformis muscles and outward through the greater sciatic foramen, these bands are continued as the sciatic and pudendal nerves. The sciatic band is derived from the lumbosacral trunk and the first three sacral nerves, the pudendal band from the second, third, and fourth sacrals.

Of the remaining branches of the plexus some arise from its anterior and some from its posterior aspect. Those arising anteriorly are the nerves to the quadratus femoris and the obturator internus, both of which leave the pelvis below the piriformis. From the posterior aspect of the plexus arise the superior gluteal nerve, which accompanies the superior gluteal vessels above the piriformis and through the upper part of the greater sciatic foramen, and the inferior gluteal and posterior femoral cutaneous nerves, which pass below the piriformis. Twigs of supply to the piriformis itself are usually derived directly from the first and second sacral nerves.

Attempt to display the sacral portions of the sympathetic trunks and the rami communicantes by which they are connected with the second and third sacral nerves. The trunks lie in front of the sacrum immediately medial to the anterior sacral foramina. At their terminations, in front of the first piece of the coccyx the trunks of the two sides communicate freely with each other.

Before completing the dissection of the hip-region and the back of the thigh, it is advisable to dissect the popliteal fossa, while the ham-string muscles, which form a part of its boundaries, are still in place. If these muscles have been partially displaced they should be restored and retained in position by cords tied around the thigh above the popliteal fossa. If the skin has not been completely reflected from the back of the knee this must

The popliteal artery begins at the tendinous opening in the adductor magnus and descends through the popliteal fossa to the lower border of the popliteus muscle, where it ends by dividing into the anterior and posterior tibial arteries. It is the most deeply placed of the structures in the fossa, being in contact with the floor (anterior wall) of the fossa throughout. Posteriorly it is covered above by the semimembranosus and below by the gastrocnemius and plantaris. The vein lies behind or medial to the artery; it may be removed, if desired, in cleaning the artery and its branches.

The constant, named branches of the popliteal artery are its five genicular branches. Its largest branches, however, are usually the somewhat variable muscular branches which are given to the hamstring muscles and the gastrocnemius, soleus, and plantaris. The two superior genicular arteries arise from either side of the popliteal and wind around the femur immediately above the condyles. The medial superior genicular runs medially in front of the semitendinosus and semimembranosus, above the medial head of the gastrocnemius and turns forward deep to the tendon of the adductor magnus. The lateral superior genicular runs laterally above the lateral condyle and in front of the biceps. The middle genicular is a small vessel which pierces the oblique popliteal ligament to enter the knee-joint; it may arise by a common stem with one of the superior geniculars. The two inferior genicular arteries arise from the lower part of the popliteal, under cover of the upper part of the gastrocnemius. The medial inferior genicular runs downward and medially to pass forward below the medial condyle of the tibia. The lateral inferior genicular runs straight laterally across the lateral condyle of the tibia and above the head of the fibula, and turns forward to reach the front of the knee-joint. All of these vessels take part in the arterial anastomosis around the knee-joint.

The origins of the hamstring muscles may now be studied more satisfactorily than was possible at earlier stages of the dissection. Observe that the long head of the biceps and the semitendinosus arise by a common tendon from the medial part of the back of the ischial tuberosity, and separate from each other a short distance below this origin. The broad flat tendon of origin of the semimembranosus lies in front of the upper part of the semitendinosus; it arises from the lateral part of the back of the ischial tuberosity. Divide the long head of the biceps just below its point of separation from

has been reflected, so that the boundaries of the fossa may be clearly defined. Then proceed to the display of the more important structures contained in the fossa.

The tibial nerve enters the popliteal fossa at its apex and descends through it almost vertically, but inclining somewhat medially. It lies superficial (posterior) to the popliteal vessels, which it crosses obliquely downward from the lateral to the medial side. It is crossed by the plantaris muscle or its tendon. The medial sural cutaneous nerve, which arises from the tibial,

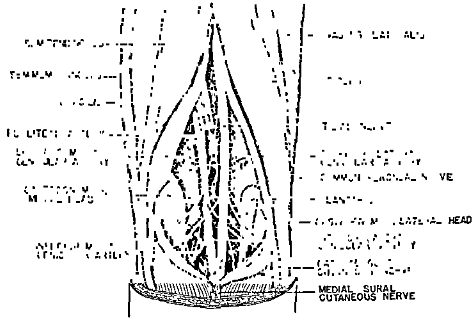

Fig. 69.—Dissection of the popliteal fossa, its boundaries have been somewhat spread apart, the better to expose the structures within.

has already been seen. In the lower part of the fossa, sometimes under cover of the gastrocnemius, the tibial nerve gives rise to a group of muscular branches. If the two heads of the gastrocnemius are spread apart, one of these branches may be followed into the deep surface of each head. A small branch is given to the plantaris. The remaining branches will be seen later to supply the soleus and popliteus muscles. In addition to these muscular and cutaneous branches the tibial nerve gives rise to two or three minute articular branches to the knee-joint.

Clean the plantaris. This is a somewhat variable muscle whose small fleshy belly is partially overlapped by the lateral head of the gastrocnemius. It arises from the lateral part of the femur immediately above the lateral condyle. Its fibres run downward and medially in the popliteal fossa to converge to a long slender tendon which descends deep to the gastrocnemius.

the gluteus minimus from its origin and reflect it completely to its insertion. As this is being done it should be noted that some of its deeper fibres arise from the joint-capsule; these should be cut away and the posterior part of the capsule cleaned.

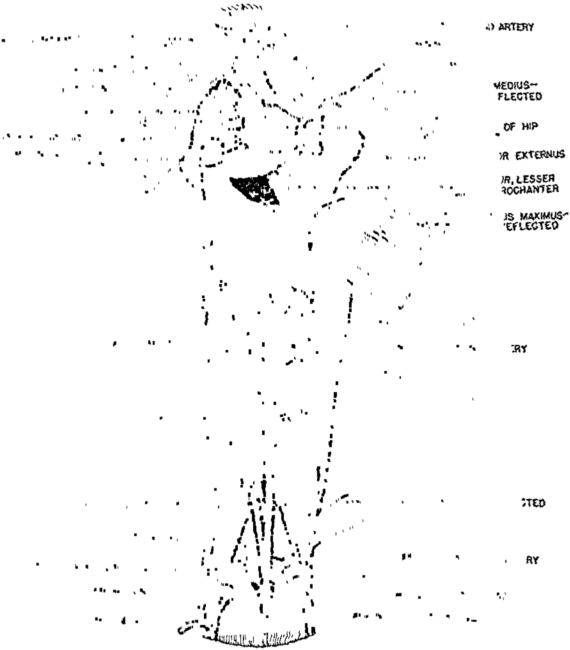

FIG. 70.—Deep dissection of the gluteal region and the back of the thigh.

The fibrous capsule of the hip-joint is attached posteriorly to the ilium and the ischium about a quarter of an inch medial to the acetabular rim; from here it stretches laterally and downward to be attached to the posterior surface of the neck of the femur. Its thickened upper portion is known as the ischiocapsular ligament; this reaches as far laterally as the upper part

the semitendinosus and turn it downward and laterally. As this is done secure its nerve of supply from the sciatic nerve. Clean also the branches which the sciatic nerve gives to the semitendinosus and semimembranosus. These usually arise from the sciatic nerve under cover of the biceps, but may appear at a higher level. Somewhat lower will be found the branch of the sciatic nerve which supplies the short head of the biceps. When these nerves have all been observed, the semimembranosus and semitendinosus should be detached from the ischial tuberosity. Each of these muscles should then be sectioned transversely at the level of the upper border of the medial condyle of the femur, and the large detached upper segments discarded. By this means the posterior surface of the adductor magnus will be exposed, and should be cleaned. The adductor magnus has already been seen to receive its main nerve-supply from the posterior division of the obturator nerve; it should now be noted that it receives an additional branch from the sciatic nerve. The terminal portions of the medial femoral circumflex and the four perforating arteries may now be observed. The medial circumflex will be found reaching the back of the thigh above the adductor magnus, between that muscle and the lower border of the quadratus femoris. The perforating arteries pierce the adductor magnus in longitudinal series close to the linea aspera. (Fig. 70.)

The posterior aspect of the capsule of the hip-joint should next be cleaned. First divide the sciatic nerve about an inch below the greater sciatic foramen and turn the distal portion downward. Then sever the tendons of the piriformis, the obturator internus, and the gemelli about three-quarters of an inch lateral to their insertions, and turn the cut ends of these muscles laterally and medially. Observe that as they approach their insertions all of these muscles lie immediately behind the joint-capsule. Observe the mucous bursa which intervenes between the deep surface of the obturator internus and the lesser sciatic notch. Detach the quadratus femoris from its insertion on the femur and turn it medially. The removal of a little fatty areolar tissue in front of the quadratus will now expose the tendon of the obturator externus, which here winds laterally and superiorly across the lower posterior part of the joint capsule to be inserted into the trochanteric fossa. The upper posterior part of the joint capsule is covered by the gluteus minimus. First cut the tensor fasciae latae away from its origin, if this has not already been done, and turn it downward; then detach

exhibits two special thickened portions which are described as distinct ligaments. The stronger of these is the iliofemoral ligament. This is a very thick triangular portion of the capsule which is attached above to the ilium immediately below the anterior inferior spine and widens out inferiorly to reach the upper two thirds of the intertrochanteric line. The pubocapsular ligament is a less well-marked thickening of the capsule which stretches *from the outer surface of the pubis near its junction with the ilium to the* lower part of the intertrochanteric line. Superiorly, between these two ligaments, the capsule is often very thin; it is here that it may communicate with the psoas bursa.

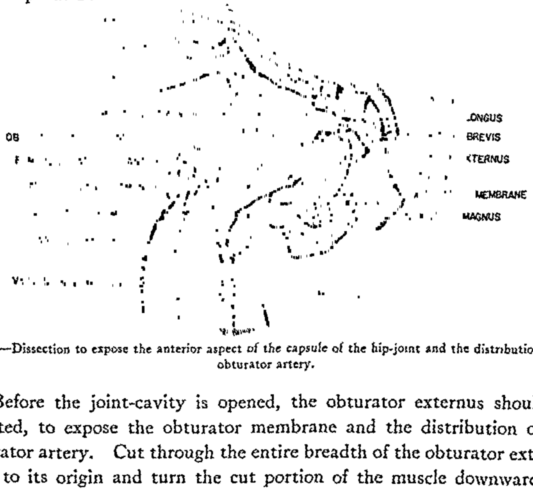

FIG. 71.—Dissection to expose the anterior aspect of the capsule of the hip-joint and the distribution of the obturator artery.

Before the joint-cavity is opened, the obturator externus should be reflected, to expose the obturator membrane and the distribution of the obturator artery. Cut through the entire breadth of the obturator externus close to its origin and turn the cut portion of the muscle downward and backward toward its insertion. As this is being done, observe the twigs of supply which it receives from the obturator nerve. Then clean the outer surface of the obturator membrane. The obturator artery will be found emerging from the pelvis at the obturator canal, in company with the obturator nerve, above the short upper free margin of the obturator membrane. It divides almost at once into an anterior and a posterior branch, which follow in their further course, the anterior and posterior borders, respectively,

of the great trochanter and is closely associated with the insertions of the piriformis, obturator internus, and gemelli.

Turn next to the front of the hip. A favorable opportunity is now offered to study the manner of origin of the rectus femoris. Observe that this muscle arises by two short strong tendons which join each other at right angles. The straight head runs downward from the anterior inferior spine of the ilium; the reflected head arises from the postero-superior surface of the border of the acetabulum in close relation to the capsule of the hip-joint, and goes forward under cover of the gluteus minimus and tensor fasciae to join the straight head. (Fig. 71.)

Review the origins of the pectineus, gracilis, and adductor muscles. Sever the gracilis close to its origin and turn it downward. Then define clearly the upper border of the adductor magnus, taking care to distinguish between this muscle and the obturator externus, which lies behind it but reaches a higher level. Then divide the adductor magnus along the entire length of its origin and reflect the main mass of the muscle backward and laterally toward its insertion. The obturator externus is now exposed and should be cleaned.

The *obturator externus* arises, under cover of the origins of the adductors brevis and magnus, from the outer surface of the ischiopubic rami along the anterior margin of the obturator foramen, and to a slight extent from the external surface of the obturator membrane. Its fibres converge laterally and posteriorly, to join a tendon which winds around the lower part of the joint capsule as already noted.

The anterior aspect of the capsule of the hip-joint is covered by the iliopsoas muscle. Sever this muscle just above its insertion into the lesser trochanter and turn it upward to expose the anterior surface of the capsule. Observe the large mucous bursa which intervenes between the deep surface of the muscle and the anterior surface of the capsule; this bursa frequently communicates with the cavity of the joint. Study of the joint capsule will be facilitated if the lower reflected portion of the ilio-psoas is completely removed by cutting through its entire thickness along the line of the inguinal ligament.

Anteriorly the articular capsule is attached to the ilium and the pubis close to the rim of the acetabulum, from which it stretches downward and laterally to be attached to the intertrochanteric line of the femur. It

of the heel, and the tendon of Achilles (tendo calcaneus) attaching to it posteriorly, are easily recognizable. On the medial border of the foot, slightly below and in front of the medial malleolus, the tuberosity of the navicular bone should be identified. Somewhat farther anteriorly, on the lateral margin of the foot, the tuberosity of the fifth metatarsal forms a prominent bony projection.

The skin is now to be reflected from the entire leg and the dorsum of the foot, to be left in place only on the sole of the foot. First remove the large skin-flap previously reflected from the thigh, cutting it away along the line where it still remains attached to the upper back part of the leg. Then make a longitudinal incision through the skin of the leg along the middle of the medial surface of the tibia as far as the lower tip of the medial malleolus. From the lower end of this incision make another incision which completely encircles the posterior part of the foot. This incision must go transversely across the front of the ankle, downward and backward below the lateral malleolus, then across the lower back part of the heel, and upward and forward below the medial malleolus, to reach its point of beginning. This will mark out one large skin flap which should now be reflected and completely removed from the entire circumference of the leg. Then make a transverse incision across the dorsum of the foot at the level of the bases of the toes, and a longitudinal incision running backward along the dorsum from the middle of this transverse incision to the front of the ankle. This will mark out two flaps of skin on the dorsum of the foot which should now be reflected to the lateral and medial borders of the foot respectively. Then proceed to study the superficial veins and cutaneous nerves.

The terminal parts of both the great and small saphenous veins have already been seen. Both of these veins arise in the dorsal venous arch. This arch is convex toward the toes and crosses the dorsum of the foot near the bases of the metatarsal bones; it receives blood from the toes through the dorsal digital and dorsal metatarsal veins. The great saphenous vein arises from the medial end of the dorsal venous arch and passes upward in front of the medial malleolus; it continues upward in the superficial fascia along the medial side of the leg a little behind the medial border of the tibia, to pass behind the medial side of the knee, from which point its further course has been traced. The small saphenous vein begins at the lateral end of the dorsal venous arch; it passes behind the lateral malleolus and upward

of the obturator foramen. The anterior branch is usually smaller than the posterior; it is distributed to the adductor muscles near their origins, and to the obturator externus. The posterior branch gives rise to an acetabular branch which pierces the joint capsule in the region of the acetabular notch, to reach the head of the femur by way of the ligamentum teres. From the posterior branch, branches are also given to the various muscles which arise from the ischial tuberosity.

The interior of the hip-joint should now be studied. Make an incision through the entire circumference of the articular capsule about half an inch proximal to its attachment to the femur. As this is done, note the extreme thickness of the ilio-femoral ligament. Then draw the head of the femur away from the acetabulum. Observe that the bones can not be drawn entirely apart, because of the presence of the ligamentum teres, a strong fibrous band which stretches between the head of the femur and the acetabular fossa. Observe that the head of the femur except at the attachment of the ligamentum teres, and the articular surface of the acetabulum, are each covered with a layer of cartilage. All other portions of the internal surface of the joint cavity are covered by the synovial stratum.

The internal ligaments of the hip-joint are the ligamentum teres, the transverse acetabular ligament, and the glenoid lip (*labrum glenoidale*). The tranverse acetabular ligament is a fibrous band which bridges across the acetabular notch and coverts it into a foramen, through which the acetabular branch of the obturator artery reaches the acetabular fossa. The glenoid lip is a fibrocartilaginous ring which surmounts the rim of the acetabulum and the transverse ligament, and thus deepens the acetabulum.

The surface landmarks of the leg and foot should be identified before the skin is reflected. Observe that the broad flat medial surface of the tibia is subcutaneous throughout its length and is continuous below with the medial malleolus, which is also subcutaneous. The shaft of the fibula is for the most part covered by muscles. The head of the fibula, however, may be palpated just below the posterior part of the lateral condyle of the tibia. At the lateral side of the ankle the lateral malleolus of the fibula is subcutaneous and is continuous above with a narrow triangular subcutaneous surface which is interposed between the anterior and the lateral surfaces of the fibula in its distal portion. The individual tarsal bones can not all be recognized. The tuberosity of the calcaneus, however, forming the prominence

of the heel, and the tendon of Achilles (tendo calcaneus) attaching to it posteriorly, are easily recognizable. On the medial border of the foot, slightly below and in front of the medial malleolus, the tuberosity of the navicular bone should be identified. Somewhat farther anteriorly, on the lateral margin of the foot, the tuberosity of the fifth metatarsal forms a prominent bony projection.

The skin is now to be reflected from the entire leg and the dorsum of the foot, to be left in place only on the sole of the foot. First remove the large skin-flap previously reflected from the thigh, cutting it away along the line where it still remains attached to the upper back part of the leg. Then make a longitudinal incision through the skin of the leg along the middle of the medial surface of the tibia as far as the lower tip of the medial malleolus. From the lower end of this incision make another incision which completely encircles the posterior part of the foot. This incision must go transversely across the front of the ankle, downward and backward below the lateral malleolus, then across the lower back part of the heel, and upward and forward below the medial malleolus, to reach its point of beginning. This will mark out one large skin flap which should now be reflected and completely removed from the entire circumference of the leg. Then make a transverse incision across the dorsum of the foot at the level of the bases of the toes, and a longitudinal incision running backward along the dorsum from the middle of this transverse incision to the front of the ankle. This will mark out two flaps of skin on the dorsum of the foot which should now be reflected to the lateral and medial borders of the foot respectively. Then proceed to study the superficial veins and cutaneous nerves.

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along the back of the calf to the popliteal fossa, where its termination in the popliteal vein has already been seen.

The cutaneous nerves of the leg and foot which should now be investigated, are the medial and lateral sural cutaneous nerves, the sural nerve, the saphenous nerve, and portions of the superficial and the deep peroneal nerves. Some variation occurs in the distribution of these nerves, but most commonly they will be found to follow approximately the description here given. The medial and lateral sural cutaneous nerves have already been seen to arise from the tibial and common peroneal nerves respectively, in or near the popliteal fossa. Their distributions should now be followed. The lateral sural cutaneous nerve is distributed to the skin on the upper lateral and antero-lateral part of the leg; it gives rise to a branch known as the peroneal anastomotic nerve which passes downward and backward across the calf and joins the medial sural cutaneous nerve to form the sural nerve. The peroneal anastomotic nerve sometimes arises independently from the *common peroneal. The medial sural cutaneous nerve accompanies the* small saphenous vein down the back of the calf. Below its junction with the peroneal anastomotic it is known as the sural nerve. The sural nerve supplies the lower lateral part of the leg and turns forward below the lateral malleolus to supply the lateral margin of the foot, where it is known as the lateral dorsal cutaneous nerve, and may be traced as far forward as the lateral side of the fifth toe.

The saphenous nerve has already been traced to the medial side of the knee, where it becomes superficial, emerging between the sartorius and the gracilis. Its further course may now be followed. It descends in company with the great saphenous vein and supplies the skin on the medial and antero-medial part of the leg as far down as the medial malleolus; branches of the saphenous nerve can often be followed for a considerable distance along the medial margin of the foot.

The superficial peroneal nerve is one of the terminal branches of the common peroneal. Its origin will be seen later. It may be found now piercing the deep fascia on the antero-lateral aspect of the leg about halfway between the knee and the ankle, or a little lower. Traced distally it divides almost at once into a medial and a lateral branch. The medial branch passes downward in front of the ankle and divides into two branches; of these the more medial passes forward to the skin along the medial side of the

great toe, while the more lateral reaches the cleft between the second and third toes and divides into two dorsal digital branches which supply the skin on the adjacent sides of these toes. The lateral branch of the superficial peroneal also gives rise to two branches, from which dorsal digital nerves arise to supply the adjacent sides of the third and fourth, and fourth and fifth toes. The terminal part of the deep peroneal nerve will be found emerging in the cleft between the bases of the great and second toes. It gives rise to two dorsal digital branches, which supply the adjacent sides of these two toes.

The muscles of the leg are arranged in three groups, each of which occupies a separate osteo-fascial compartment. Superficially each compartment is limited by the deep fascia which encircles the leg; the deep boundaries of the various compartments are formed by the bones and the fascial septa of the leg. The muscles of the anterior group, which flex the foot and extend the toes, are in relation to the anterior surfaces of the fibula and the interosseus membrane and the lateral surface of the tibia. The muscles of the posterior group, which extend the foot and flex the toes, are in relation to the posterior and medial surfaces of the fibula and the posterior surfaces of the interosseus membrane and the tibia. The lateral muscles, which are primarily evertors of the foot, occupy a narrow compartment which is limited deeply by the lateral surface of the fibula and separated anteriorly and posteriorly from the lateral parts of the anterior and posterior compartments by short fascial intermuscular septa. Medially the subcutaneous medial surface of the tibia intervenes between the muscles of the anterior and posterior groups. The deep fascia covering this surface of the tibia is intimately blended with the periosteum. The anterior compartment should be first examined. Before doing this, however, it is advisable to clean and study the patellar ligament and the insertions of the sartorius, gracilis, and semitendinosus muscles. (Fig. 72.)

The patellar ligament is a strong, flat fibrous band which extends from the distal border of the patella to the tuberosity of the tibia, and represents the actual insertion of the four parts of the quadriceps femoris. It is an integral part of the capsule of the knee-joint, as will be apparent when the joint is dissected. The sartorius, gracilis, and semitendinosus are all inserted close together on the upper part of the medial surface of the tibia. Observe that the flat tendon of insertion of the sartorius covers the other

two tendons externally and that the gracilis lies at its insertion immediately above the semitendinosus and partially overlaps it.

Before cleaning the individual muscles of the anterior crural compartment, attempt to define the transverse and cruciate ligaments. These ligaments are merely thickened portions of the deep fascia of the leg. The transverse crural ligament stretches across the front of the leg just proximal to the malleoli; laterally it blends with the periosteum of the triangular subcutaneous surface of the fibula, and medially with the tibia. The cruciate crural ligament is somewhat lower. Laterally it is a single band, which stretches medially across the front of the ankle-joint from the anterior part of the calcaneus; in front of the middle of the joint it divides into two limbs, one of which passes proximally, to reach the medial malleolus, while the other passes distally and turns around the medial margin of the foot to join the plantar aponeurosis.

The muscles in the anterior compartment should now be cleaned. As the deep fascia covering them is removed, the transverse and cruciate ligaments should for the present be retained. Further, it will be found that the deep fascia covering these muscles in the upper part of the leg can not all satisfactorily be removed, since the muscles take origin partially from its deep surface. The muscles of the anterior compartment are the tibialis anterior, the extensor digitorum longus, the peroneus tertius, and the extensor hallucis longus; in addition to these muscles the compartment contains the anterior tibial artery and its accompanying veins and the deep peroneal nerve.

The tibialis anterior arises from the proximal half of the lateral surface of the tibia, the medial side of the anterior surface of the interosseus membrane, and from the deep fascia which covers it. Its fibres converge distally to a strong tendon which passes over the front of the ankle-joint on to the dorsum of the foot, deep to the transverse and cruciate ligaments. It is inserted into the medial part of the first cuneiform bone and the adjoining part of the base of the first metatarsal.

The extensor digitorum longus arises from the anterior part of the head of the fibula and the proximal two thirds of the anterior surface of the shaft, from the anterior surface of the intermuscular septum separating it from the lateral crural compartment, and from the deep fascia covering it. Its tendon descends in front of the ankle-joint, and on the dorsum of the foot

divides into four slips, which reach the dorsal surfaces of the four lateral toes. The skin should be reflected from the dorsum of one or two of the toes, and the manner of insertion of these slips investigated. Observe that each slip expands on the dorsal aspect of the first phalanx and then divides into a central and two collateral parts. The central part is inserted into the base of the second phalanx: the collateral parts are prolonged distally to be inserted together into the base of the terminal phalanx.

The peroneus tertius, while described as a separate muscle, usually has more the appearance of an additional slip of the extensor digitorum longus. It is continuous at its origin, which is from the distal part of the anterior surface of the fibula, with the latter muscle. Its slender tendon is inserted into the dorsal side of the base of the fifth metatarsal.

The extensor hallucis longus lies between the tibialis anterior and the extensor digitorum longus, but does not reach as high a level as do these two muscles. Its proximal portion is covered by these muscles, which must be separated to expose it. It arises from the middle half of the anterior surface of the fibula, medial to the attachment of the extensor digitorum longus, and from the anterior surface of the adjacent part of the interosseous membrane. Its tendon crosses the front of the ankle joint just lateral to the tibialis anterior, and passes proximally on the dorsum of the foot to be inserted into the terminal phalanx of the great toe.

Three closed mucous sheaths are found in relation to the tendons of these muscles, in front of the ankle and on the dorsum of the foot. They can not usually be very satisfactorily demonstrated in the ordinary dissecting room part, but an attempt should be made to inflate them with air by means of a blow-pipe, or to explore their limits with a blunt flexible probe. The most medial sheath encircles the tendon of the tibialis anterior and extends from about the proximal border of the transverse crural ligament to within a short distance of the insertion of the muscle. A second sheath encloses the tendon of the extensor hallucis longus and extends from about the distal border of the transverse ligament to the base of the first phalanx of the great toe. The third sheath is common to the tendons of the extensor digitorum longus and the peroneus tertius; it extends from the distal border of the transverse ligament to about the middle of the dorsum of the foot.

Cut away the transverse crural ligament and displace the tibialis anterior medially and the remaining muscles of the anterior compartment lat-

erally, and clean and study the anterior tibial artery and the deep peroneal nerve. The anterior tibial is one of the terminal branches of the popliteal artery. It enters the anterior compartment by piercing the proximal part

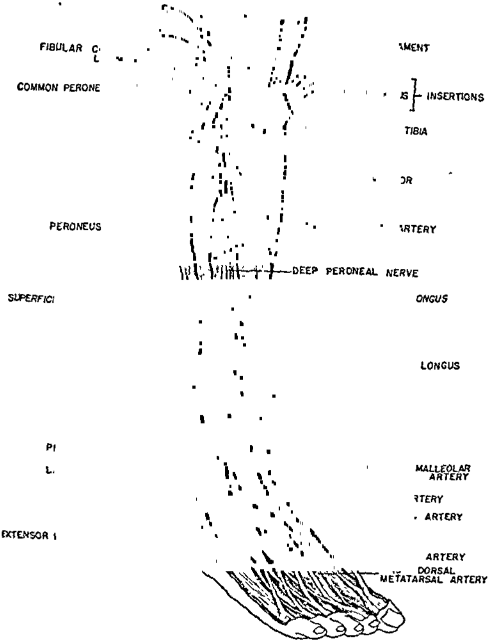

FIG. 72.—Dissection of the anterior compartment of the leg, and the dorsum of the foot. The muscles of the anterior compartment have been somewhat displaced, to expose the anterior tibial artery and the deep peroneal nerve.

of the interosseus membrane close to the neck of the fibula. It descends in the anterior compartment on the interosseous membrane, lying first between the tibialis anterior and the extensor digitorum longus and then between the tibialis anterior and the extensor hallucis longus. In the distal part of the leg it rests on the anterior surface of the tibia and is crossed ante-

riorly by the tendon of the extensor hallucis longus; it becomes superficial just proximal to the ankle, where it lies between the tendons of the last-named muscle and the extensor digitorum longus. It ends in front of the ankle joint, from which point its continuation is known as the dorsal artery of the foot (a. dorsalis pedis). In addition to numerous branches to the muscles of the anterior compartment, it gives rise to the anterior tibial recurrent and the medial and lateral anterior malleolar arteries. The anterior tibial recurrent arises from the anterior tibial in the proximal part of its course and ascends through the substance of the upper part of the tibialis anterior to reach the front of the knee-joint. The anterior malleolar arteries are small vessels which arise from either side of the anterior tibial just proximal to the ankle. The lateral anterior malleolar runs laterally deep to the tendons of the extensor digitorum longus and peroneus tertius and turns posteriorly on the lateral surface of the lateral malleolus. The medial anterior malleolar crosses the distal portion of the tibia deep to the tendons of the extensor hallucis longus and the tibialis anterior.

The perforating branch of the peroneal artery should also be exposed at this time. The peroneal artery itself will be seen when the posterior crural compartment is studied. Its perforating branch enters the anterior compartment by piercing the interosseous membrane about an inch and a half above the lateral malleolus, to descend in front of the distal part of the fibula and anastomose with the lateral anterior malleolar artery. It is usually a small vessel, but in some cases is greatly enlarged and continued on to the dorsum of the foot as the dorsalis pedis artery; in such cases the anterior tibial, which normally gives rise to the dorsalis pedis, ends in small twigs to the ankle-joint.

The deep peroneal nerve is one of the terminal branches of the common peroneal. It will be found entering the anterior compartment by piercing the upper part of the extensor digitorum longus. It accompanies the anterior tibial artery distally to the front of the ankle-joint, from which point it accompanies the dorsalis pedis artery on to the dorsum of the foot. It lies to the lateral side of the anterior tibial throughout, with the exception that in the middle third of the leg it may lie in front of the artery. It gives branches of supply to the four muscles of the anterior compartment.

The deeper structures which are now to be displayed on the dorsum of the foot are the extensor digitorum brevis, the dorsalis pedis artery and its

erally, and clean and study the anterior tibial artery and the deep peroneal nerve. The anterior tibial is one of the terminal branches of the popliteal artery. It enters the anterior compartment by piercing the proximal part

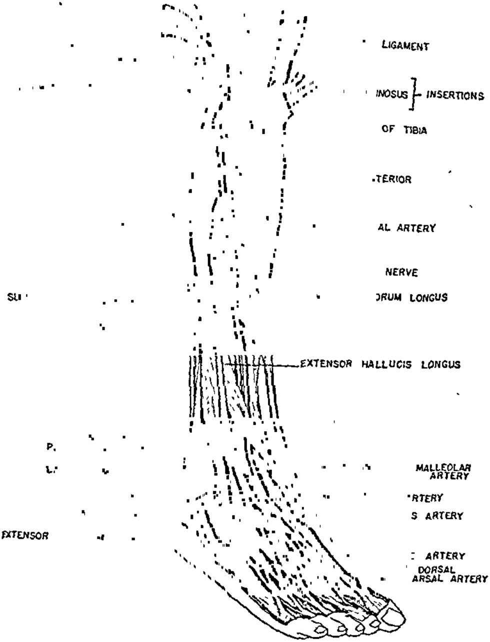

FIG. 72.—Dissection of the anterior compartment of the leg, and the dorsum of the foot. The muscles of the anterior compartment have been somewhat displaced, to expose the anterior tibial artery and the deep peroneal nerve.

of the interosseus membrane close to the neck of the fibula. It descends in the anterior compartment on the interosseous membrane, lying first between the tibialis anterior and the extensor digitorum longus and then between the tibialis anterior and the extensor hallucis longus. In the distal part of the leg it rests on the anterior surface of the tibia and is crossed ante-

The deep peroneal nerve lies lateral to the first part of the dorsalis pedis artery. A *short distance distal to the ankle joint it terminates by dividing* into a lateral and a medial branch. The lateral branch passes deep to the extensor digitorum brevis and supplies that muscle and the tarsal joints. The medial branch passes forward with the dorsalis pedis artery; its distribution to the skin on the adjacent sides of the first and second toes has already been seen.

The lateral crural region is next to be examined. First clean and study the insertion of the biceps femoris. This muscle is inserted into the highest part of the head of the fibula, and also gives a tendinous expansion to the fascia covering the lateral part of the leg. Observe that its insertion is split into two parts just above its attachment to the fibula, by the fibular collateral ligament. This is a strong rounded cord, which extends from the upper lateral part of the lateral condyle of the femur downward to the lateral surface of the head of the fibula. Its upper part is covered externally by the biceps, which it pierces just above the head of the fibula. (Fig. 72.)

The lateral crural compartment contains only two muscles, the peroneus longus and the peroneus brevis. Before cleaning them attempt to define the peroneal retinacula. These are similar to the transverse crural and cruciate ligaments, and represent thickenings in the deep fascia which serve to hold the tendons of the peroneal muscles in place against the calcaneus. The superior peroneal retinaculum passes from the posterior distal part of the lateral malleolus downward and backward to the upper lateral part of the calcaneus. The inferior peroneal retinaculum takes a similar direction from the upper anterior part of the calcaneus, where it is continuous with the lateral end of the cruciate ligament, to the trochlear process of the calcaneus. Retaining *the peroneal retinacula for the present,* clean the peroneus longus by removing the remaining portions of deep fascia as completely as possible from its outer surface.

The peroneus longus arises from the proximal half of the lateral surface of the fibula, from the anterior and posterior fibular intermuscular septa, and to some extent from the deep fascia which covers it externally. Its fibres converge to a strong tendon which passes distally, lateral to the peroneus brevis, and then across the lateral surface of the calcaneus behind and below the lateral malleolus, and on a groove in the cuboid bone into the sole of the foot, where its further course will be seen later. As it lies against the

branches, and the terminal part of the deep peroneal nerve. To render them more accessible it is advisable to cut away the cruciate ligament, so that the tendons of the extensor digitorum longus and the peroneus tertius may be displaced laterally. Then clean the extensor digitorum brevis.

The extensor digitorum brevis arises from the lateral and superior surfaces of the body of the calcaneus. As its fibres pass distally they divide into four fleshy bellies, each of which gives rise to a separate small tendon. The most medial of these muscular bellies is sometimes described as a separate muscle, the extensor hallucis brevis. Its tendon is inserted into the dorsum of the first phalanx of the great toe. The remaining three tendons are given to the second, third, and fourth toes. They are not, however, inserted directly upon the phalanges of these toes, but each joins the lateral side of the corresponding tendon of the long extensor near the base of the first phalanx. (Fig. 72.)

Clean the dorsalis pedis artery and its branches. The dorsalis pedis begins in front of the ankle joint as a continuation of the anterior tibial, and extends to the base of the first interosseous space, where it ends by dividing into the deep plantar and first dorsal metatarsal arteries. Deeply, it rests successively on the talus, the navicular bone, the second cuneiform, and the base of the second metatarsal. As it crosses the tarsal bones it gives rise to a lateral tarsal and (usually) two medial tarsal branches. The lateral tarsal courses laterally deep to the extensor digitorum brevis and supplies this muscle and the bones and articulations of the region. The medial tarsals are small twigs which supply the skin and the bones in the medial tarsal region. Near its termination the dorsalis pedis gives rise to the arcuate artery. This vessel runs laterally across the bases of the metatarsal bones; from it arise the second, third, and fourth dorsal metatarsal arteries. Each dorsal metatarsal artery passes forward along the corresponding interosseous space and divides into two dorsal digital branches which are distributed to the adjacent sides of two toes. The dorsal metatarsal artery of the first space is, as has been seen, one of the terminal branches of the dorsalis pedis; it gives rise usually to a branch which supplies the medial side of the great toe. The other terminal branch, the deep plantar artery, passes downward through the base of the first interosseous space into the sole of the foot, where, as will be seen later, it takes part in the formation of the deep plantar arch.

facet on the posterior surface of the medial condyle of the tibia, medial to the medial head of the gastrocnemius, and partially overlapped by it. A mucous bursa is usually found to intervene between the semimembranosus tendon and the medial head of the gastrocnemius. Divide the two heads of the gastrocnemius about half an inch below their attachments to the femur and reflect the entire muscle downward and backward to its junction with the tendon of Achilles. As this is being done observe the branches

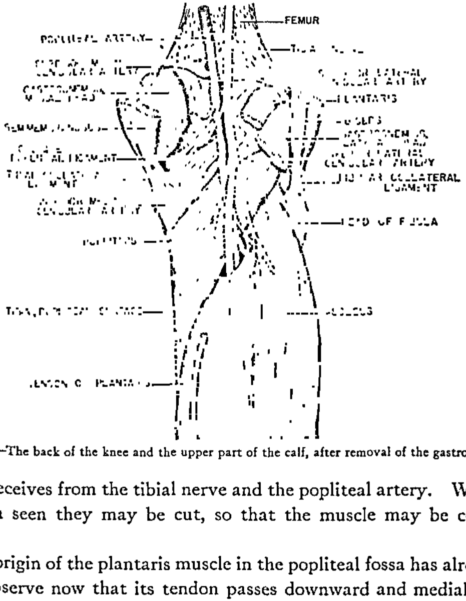

FIG. 73.—The back of the knee and the upper part of the calf, after removal of the gastrocnemius.

which it receives from the tibial nerve and the popliteal artery. When these have been seen they may be cut, so that the muscle may be completely reflected.

The origin of the plantaris muscle in the popliteal fossa has already been seen. Observe now that its tendon passes downward and medially behind the popliteal artery and the tibial nerve, and descends between the gastrocnemius and soleus, to join the tendon of Achilles. It also is supplied by a twig from the tibial nerve. Divide the plantaris just below its origin and turn it downward. Then clean and study the popliteus and soleus muscles. (Fig. 73.)

calcaneus, deep to the peroneal retinacula, this tendon is enclosed in a mucous sheath which is common to it and the peroneus brevis.

Draw the lower part of the peroneus longus laterally and posteriorly and expose and clean the peroneus brevis. This muscle arises from the distal half of the lateral surface of the fibula and from the fibular intermuscular septa. Its tendon is at first covered by the tendon of the peroneus longus, but as it turns forward across the calcaneus, it appears immediately above the latter tendon. It is inserted into the tuberosity at the base of the fifth metatarsal bone. (Fig. 72.)

The common peroneal nerve has been followed downward and laterally along the border of the biceps femoris to the head of the fibula. At the posterior border of the upper part of the peroneus longus it disappears from view by passing deep to that muscle, between it and the neck of the fibula. Now cut carefully down through the substance of the peroneus longus, to expose the further course of the nerve. Observe that as it crosses the neck of the fibula, the common peroneal nerve gives off a small recurrent articular branch to the knee joint and then divides into the deep and superficial peroneal nerves. The deep peroneal nerve passes through the upper part of the extensor digitorum longus, from which point its further course has been traced. The superficial peroneal nerve passes distally to reach the interval between the peronei longus and brevis, both of which it supplies; in the distal part of the leg it pierces the deep fascia, from which point its distribution as a cutaneous nerve of the leg and foot has been seen.

Turn now to the posterior crural region. The muscles of this region are arranged in three layers from without inward. The muscles of the superficial layer are the gastrocnemius, plantaris, and soleus, and constitute the fleshy prominence known as the calf. The upper part of the gastrocnemius has already been seen in connection with the popliteal fossa. The entire external surface of this muscle should now be cleaned.

The gastrocnemius arises by two heads which take origin from the upper posterior parts of the lateral and medial condyles of the femur, and join below the popliteal fossa. The muscle is fleshy above and tendinous below. It is inserted into the tuberosity of the calcaneus through the tendon of Achilles (tendo calcaneus), which is common to the gastrocnemius, plantaris, and soleus. Before reflecting the gastrocnemius, clean and study the tendon of insertion of the semimembranosus. This muscle is inserted into a

plantaris, and soleus may now be cut off and discarded, if desired, leaving only the distal portion of the tendon of Achilles attached to the calcaneus.

The second layer in the posterior crural compartment consists of two muscles, the flexor hallucis longus and the flexor digitorum longus. Before cleaning these muscles, clean and define the laciniate ligament. This ligament is a thickened portion of the deep fascia at the medial side of the heel. It is a strong fascial band which stretches downward and backward from the medial malleolus to the prominence on the posterior part of the medial surface of the calcaneus, and serves to retain in position against the talus and the calcaneus the tendons of the tibialis posterior, the flexor digitorum longus, and the flexor hallucis longus, and the terminal portions of the tibial nerve and the posterior tibial artery. Piercing it will be found some small medial calcaneal branches of the tibial nerve, which supply the skin on the medial side of the heel; they are accompanied by the medial calcaneal branches of the posterior tibial artery. Retaining the laciniate ligament, proceed to clean and study the flexor digitorum longus and the flexor hallucis longus. The posterior tibial artery will be found to descend through the posterior crural compartment, in company with the tibial nerve, in the groove between the adjacent borders of these two muscles. (Fig. 74.)

The flexor digitorum longus arises from the distal part of the popliteal line and the middle half of the medial side of the posterior surface of the tibia; its fibres pass obliquely downward to join a tendon which passes behind the medial malleolus and deep to the laciniate ligament. The flexor hallucis longus arises from the distal two thirds of the posterior surface of the fibula. Its tendon also passes deep to the laciniate ligament, lying a short distance behind the tendon of the flexor digitorum longus.

The third layer of the posterior crural compartment is represented by a single muscle, the tibialis posterior. Except for its most proximal portion this muscle is covered posteriorly by the two muscles of the second layer. It can therefore be studied to better advantage if the flexor hallucis longus and the flexor digitorum longus are spread laterally and medially respectively. First, however, it is advisable to clean the posterior tibial artery and the tibial nerve.

The posterior tibial artery begins at the lower border of the popliteus and descends in front of the soleus and between the flexor digitorum longus and the flexor hallucis longus. It is in relation anteriorly, successively from

The popliteus is a flat triangular muscle which lies in front of the lower part of the popliteal artery in relation to the *popliteal surface of the tibia;* it is covered by a fairly dense layer of fascia. Its tendon of origin arises *within the cavity of the knee-joint* from the lower lateral part of the lateral condyle of the femur. It may now be found emerging from the lateral side of the posterior aspect of the joint-capsule. From this tendon muscle fibres diverge downward and medially to cover the popliteal surface of the tibia, upon which they are inserted. The popliteus is supplied by a branch of the tibial nerve, which arises in the popliteal fossa, and usually winds around the lower border of the muscle to reach its deep surface.

The soleus is a thick fleshy muscle whose long linear origin has roughly the outline of an inverted V. It arises from the middle third of the medial border of the tibia, from the popliteal line on the back of the tibia, from a strong fibrous band (arcus tendineus m. solei) which bridges across the interval between the upper end of the popliteal line and the head of the fibula, from the posterior surface of the head of the fibula, and from the upper third of the posterior surface of the fibula. It is inserted, together with the plantaris and the gastrocnemius, by means of the tendon of Achilles into *the tuberosity of the calcaneus. Find and clean the nerve of supply which* arises from the tibial nerve in the popliteal fossa and enters the proximal part of the external surface of the soleus.

The terminal part of the popliteal artery may now be seen to better advantage than was possible when the popliteal fossa was dissected. The popliteal artery ends, usually opposite the lower border of the popliteus, by dividing into the anterior and posterior tibial arteries. Observe that these two vessels and the tibial nerve descend into the leg by passing in front of the fibrous band between the tibia and fibula, from which the soleus takes partial origin.

Detach the soleus entirely from its origin and reflect it downward and backward toward the calcaneus. As this is being done, observe that its deep surface receives an additional nerve of supply, which arises from the tibial nerve in the leg, and several branches from the posterior tibial artery. When these have been cleaned, they should be cut, so that the muscle may be completely reflected. Observe that in front of the tendon of Achilles, between it and the posterior aspect of the ankle joint, is a considerable amount of fatty areolar tissue. The reflected portions of the gastrocnemius,

cover of the laciniate ligament by dividing into the medial and lateral plantar arteries.

The tibial nerve is at first medial to the posterior tibial artery, but soon crosses behind it and for the rest of its course lies on the lateral side of the artery. It gives a branch to the deep surface of the soleus and branches which supply the flexor digitorum longus, the flexor hallucis longus, and the tibialis posterior. It terminates under cover of the laciniate ligament by dividing into the medial and lateral plantar nerves. Just proximal to its termination it gives a small articular twig to the ankle joint and the medial calcaneal cutaneous branches which have already been seen.

The tibialis posterior should now be cleaned. It arises from the upper two-thirds of the lateral part of the posterior surface of the tibia below the popliteal line, from the entire medial surface of the fibula, and from the posterior surface of the upper two-thirds of the interosseous membrane. Its tendon passes distally and medially deep to the flexor digitorum longus, behind the medial malleolus and deep to the laciniate ligament, where it lies immediately in front of the tendon of the flexor digitorum longus.

Displace the flexor hallucis longus laterally and trace the further course of the peroneal artery. This vessel descends in close relation to the fibula, between the tibialis posterior and the flexor hallucis longus, giving branches to those muscles and to the peronei longus and brevis. In the distal part of the leg it lies on the interosseous membrane and here gives rise to the perforating branch which has already been seen on the front of the leg. Behind the lateral malleolus it gives rise to a posterior lateral malleolar branch which passes forward across the lateral malleolus to anastomose with the anterior lateral malleolar. The peroneal artery terminates in some small lateral calcaneal branches which ramify on the lateral side of the heel.

The course of the anterior tibial artery in the anterior crural compartment has already been traced. Observe now that its course in the posterior crural region is very short. From its origin it runs downward and forward to pierce the proximal part of the interosseous membrane above the tibialis posterior. Before piercing the membrane, however, it gives rise to a posterior tibial recurrent branch, which ascends, deep to the popliteus muscle, to reach the knee-joint.

The laciniate ligament should now be reflected, properly to expose the terminations of the tibial nerve and the posterior tibial artery and the relative

above downward, with the tibialis posterior, the posterior surface of the tibia, and the capsule of the ankle joint. Its largest branch is the peroneal *artery;* *this vessel* arises about an inch below the origin of the posterior tibial, and runs laterally and distally across the tibialis posterior, to pass from view

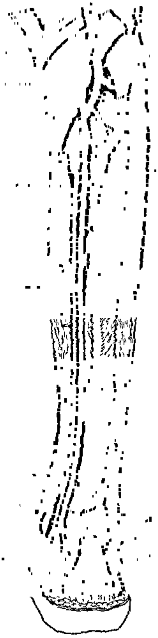

FIG. 74.—The posterior aspect of the leg, after removal of the gastrocnemius and soleus.

at present under cover of the flexor hallucis longus. The posterior tibial gives muscular branches to the soleus and the deeper posterior crural muscles, several small medial calcaneal branches, and a posterior medial malleolar branch, which runs forward across the medial malleolus to anastomose with the anterior medial malleolar branch of the anterior tibial. It ends under

cover of the laciniate ligament by dividing into the medial and lateral plantar arteries.

The tibial nerve is at first medial to the posterior tibial artery, but soon crosses behind it and for the rest of its course lies on the lateral side of the artery. It gives a branch to the deep surface of the soleus and branches which supply the flexor digitorum longus, the flexor hallucis longus, and the tibialis posterior. It terminates under cover of the laciniate ligament by dividing into the medial and lateral plantar nerves. Just proximal to its termination it gives a small articular twig to the ankle joint and the medial calcaneal cutaneous branches which have already been seen.

The tibialis posterior should now be cleaned. It arises from the upper two-thirds of the lateral part of the posterior surface of the tibia below the popliteal line, from the entire medial surface of the fibula, and from the posterior surface of the upper two-thirds of the interosseous membrane. Its tendon passes distally and medially deep to the flexor digitorum longus, behind the medial malleolus and deep to the laciniate ligament, where it lies immediately in front of the tendon of the flexor digitorum longus.

Displace the flexor hallucis longus laterally and trace the further course of the peroneal artery. This vessel descends in close relation to the fibula, between the tibialis posterior and the flexor hallucis longus, giving branches to those muscles and to the peronei longus and brevis. In the distal part of the leg it lies on the interosseous membrane and here gives rise to the perforating branch which has already been seen on the front of the leg. Behind the lateral malleolus it gives rise to a posterior lateral malleolar branch which passes forward across the lateral malleolus to anastomose with the anterior lateral malleolar. The peroneal artery terminates in some small lateral calcaneal branches which ramify on the lateral side of the heel.

The course of the anterior tibial artery in the anterior crural compartment has already been traced. Observe now that its course in the posterior crural region is very short. From its origin it runs downward and forward to pierce the proximal part of the interosseous membrane above the tibialis posterior. Before piercing the membrane, however, it gives rise to a posterior tibial recurrent branch, which ascends, deep to the popliteus muscle, to reach the knee-joint.

The laciniate ligament should now be reflected, properly to expose the terminations of the tibial nerve and the posterior tibial artery and the relative

positions of these structures and the three flexor tendons. Observe that under cover of the laciniate ligament, these structures are arranged in the following order from before backward (or, as sometimes described, from medial to lateral): the tendon of the tibialis posterior, the tendon of the flexor digitorum longus, the posterior tibial artery, the tibial nerve, and the tendon of the flexor hallucis longus. The three tendons and the medial and lateral plantar nerves and arteries, which arise here, all pass distally into the sole of the foot.

The capsule of the knee-joint should now be cleaned. First define clearly the inferior margins of the distal parts of the vasti muscles; observe that while these muscles for the most part are attached either directly or by means of the tendon of the quadriceps to the proximal border of the patella, tendinous expansions known as the patellar retinacula, also pass distally from them to join the articular capsule. The capsule is covered on its lateral side by the biceps femoris; the short head of this muscle should now be detached from its origin on the femur and the entire muscle removed, except for the distal portion of its tendon of insertion, which may be left attached to the head of the fibula. The semimembranosus must also be removed from the capsule, except for about half an inch proximal to its attachment to the tibia. With removal of the biceps the full extent of the fibular collateral ligament, whose distal end was already seen piercing the tendon of the biceps, will be exposed, and should be cleaned. This is the only one of the external ligaments of the knee-joint which is not intimately blended with the articular capsule. Make a longitudinal incision through the middle of the quadriceps tendon a short distance above the patella, to open the suprapatellar bursa. This bursa lies between the deep surface of the quadriceps tendon and the anterior surface of the distal part of the shaft of the femur; it is continuous distally with the articular cavity of the knee-joint.

Attempt to demonstrate the arterial anastomosis which is found on the anterior aspect of the knee-joint encircling the patella. The terminal portions of six arteries, the proximal parts of all of which have already been cleaned, take part in this anastomosis. They are the musculo-articular branch of the supreme genicular from the femoral, the medial and lateral superior and inferior genicular branches of the popliteal, and the anterior tibial recurrent of the anterior tibial.

The external ligaments of the knee-joint include the fibular collateral ligament, the patellar ligament, the tibial collateral ligament, and the oblique popliteal and arcuate popliteal ligaments; with the exception of the fibular collateral ligament all are intimately blended with the fibrous capsule of the joint.

The fibular collateral and patellar ligaments have already been cleaned. The tibial collateral ligament is a strong flat band lying on the medial side of the joint under cover of the tendons of the sartorius, gracilis, and semitendinosus. It extends from the medial condyle of the femur to the uppermost portion of the medial surface of the tibia, below the medial condyle. The oblique and arcuate popliteal ligaments are thickenings in the posterior part of the capsule. The oblique popliteal ligament lies in front of the middle portion of the popliteal artery; it extends upward and laterally across the back of the joint from the posterior aspect of the medial condyle of the tibia. Observe that it receives a strong band of fibres from the tendon of insertion of the semimembranosus. The arcuate popliteal ligament lies at the postero-lateral side of the knee, extending from the apex of the head of the fibula, upward to the back of the lateral condyle of the femur; the tendon of the popliteus muscle emerges from the joint-capsule at the medial border of this ligament.

Divide the entire thickness of the quadriceps femoris transversely about two inches above the patella, and turn the distal segment of the muscle downward and forward. Then open the knee-joint from the front, by dividing the anterior part of the articular capsule close to its line of attachment to the distal portion of the anterior surface of the femur. Flex the knee completely, draw the distal portion of the quadriceps with the attached patella downward and forward, and study the interior of the joint. (Fig. 75.)

The bony articular surfaces of the knee-joint include the condyles and the patellar surface of the femur, the superior articular surface of the tibia, and the internal surface of the patella. Observe that each of these surfaces is covered by a layer of cartilage. Elsewhere the cavity of the joint is lined by the synovial membrane, between which and the fibrous capsule are numerous large depositions of fat. Observe the patellar synovial fold; this is a fat-filled fold of the synovial stratum, which runs from the lower border of the patella back to the intercondyloid fossa of the femur.

The internal ligaments of the knee-joint include the medial and lateral menisci, the transverse ligament, and the anterior and posterior cruciate ligaments. The menisci may be seen without dissection. They are two semi-lunar fibro-cartilaginous discs which rest upon the outer portions of the articular surfaces of the condyles of the tibia, and partially separate these surfaces from the corresponding articular surfaces of the condyles of the femur. Their inner margins are sharp and free; their outer margins are thicker and attached to the fibrous capsule of the joint.

FIG. 75.—The interior of the knee-joint as seen from the front. The knee is flexed and the patella drawn downward. The femoral attachment of the patellar synovial fold has been cut away, to expose the cruciate ligaments.

To expose the transverse and the cruciate ligaments it will be necessary to clear away the patellar synovial fold and the fat contained in it. The transverse ligament is a fibrous cord which extends across the anterior margin of the upper surface of the tibia from the rounded anterior margin of the lateral meniscus to the sharp anterior extremity or cornu of the medial meniscus. The cruciate ligaments are strong fibrous bands which occupy the intercondyloid fossa of the femur. The anterior cruciate ligament extends upward, backward, and laterally, from the anterior intercondyloid fossa of the tibia to the medial surface of the lateral condyle of the femur. The posterior cruciate ligament is partly covered anteriorly by the anterior

ligament. It extends upward and medially from the posterior intercondyloid fossa of the tibia to the lateral surface of the medial condyle of the femur.

Extend the knee, divide the posterior portion of the capsule of the joint, and observe the origin of the popliteus muscle from the lower lateral part of the lateral condyle of the femur, within the cavity of the joint. Section this muscle close to its origin, divide the cruciate ligaments, and disarticulate the femur. Then proceed to the dissection of the sole of the foot.

Make a transverse incision through the skin across the sole of the foot at the bases of the toes. From the middle of this incision carry a longitudinal incision backward to the heel. Then reflect the two skin flaps thus marked out to either side. The skin should also be reflected from the plantar aspect of the toes. This may be done by means of a longitudinal incision along the middle of each toe. Observe that the plantar skin is very thick and is closely bound to the superficial fascia by means of fibrous strands which extend through the superficial fascia from the plantar aponeurosis to reach the skin. Remove the superficial fascia and clean the plantar aponeurosis.

The plantar aponeurosis stretches forward from the calcaneus, to which it is firmly attached posteriorly, to cover the superficial muscles on the plantar aspect of the foot. It is subdivided into narrow medial and lateral portions, which are relatively thin, and a broad, thick intermediate portion. As it reaches forward from the calcaneus this portion widens out and toward the bases of the toes divides into five digital slips, which end anteriorly by blending with the fibrous sheaths which bind the flexor tendons down to the plantar surfaces of the metatarso-phalangeal joints and the phalanges.

The superficial muscles of the sole should now be cleaned. These are the abductor hallucis, the flexor digitorum brevis, and the abductor digiti quinti. They are covered by the medial, intermediate, and lateral portions, respectively, of the plantar aponeurosis. This aponeurosis must therefore be removed in cleaning them; its posterior portion can not, however, be successfully removed, since the muscles take origin in part from its deep surface. As the muscles are being cleaned, care must be taken to preserve the medial plantar nerve, which emerges between the abductor hallucis and the flexor digitorum brevis, and the superficial branch of the lateral plantar nerve, which appears at the lateral side of the flexor digitorum brevis.

The abductor hallucis arises from the medial process of the tuberosity of the calcaneus and from the portion of the plantar aponeurosis which covers

The internal ligaments of the knee-joint include the medial and lateral menisci, the transverse ligament, and the anterior and posterior cruciate ligaments. The menisci may be seen without dissection. They are two semi-lunar fibro-cartilaginous discs which rest upon the outer portions of the articular surfaces of the condyles of the tibia, and partially separate these surfaces from the corresponding articular surfaces of the condyles of the femur. Their inner margins are sharp and free; their outer margins are thicker and attached to the fibrous capsule of the joint.

FIG. 75.—The interior of the knee-joint as seen from the front The knee is flexed and the patella drawn downward. The femoral attachment of the patellar synovial fold has been cut away, to expose the cruciate ligaments.

To expose the transverse and the cruciate ligaments it will be necessary to clear away the patellar synovial fold and the fat contained in it. The transverse ligament is a fibrous cord which extends across the anterior margin of the upper surface of the tibia from the rounded anterior margin of the lateral meniscus to the sharp anterior extremity or cornu of the medial meniscus. The cruciate ligaments are strong fibrous bands which occupy the intercondyloid fossa of the femur. The anterior cruciate ligament extends upward, backward, and laterally, from the *anterior intercondyloid fossa* of the tibia to the medial surface of the lateral condyle of the femur. The posterior cruciate ligament is partly covered anteriorly by the anterior

the medial side of the plantar aspect of the great toe. The remaining three, which are known as common plantar digital nerves, each divide near the heads of the metatarsal bones into two proper plantar digital nerves, which supply the adjacent sides of the first and second, second and third, and third and fourth toes, respectively. The superficial branch of the lateral plantar nerve emerges from under cover of the lateral side of the flexor digitorum brevis and divides into two branches; the more medial of these gives rise to two proper digital branches which supply the adjacent sides of the fourth and fifth toes, and the more lateral supplies the lateral side of the fifth toe.

The second layer of muscles in the sole of the foot includes the tendons of the flexor hallucis longus and the flexor digitorum longus, the quadratus plantae, and the four lumbrical muscles. At this same level will be found the trunks of the medial plantar nerve and artery, crossing deep to the abductor hallucis, and the lateral plantar nerve and artery, which cross deep to both the abductor hallucis and the flexor digitorum brevis. (Fig. 77.)

Divide the abductor hallucis and the flexor digitorum brevis close to their origins and reflect them forward. As this is done, secure the nerves of supply which they receive from the medial plantar nerve. The beginnings of the medial plantar nerve and artery under cover of the lactiniate ligament have already been seen. Their full course may now be traced. In addition to the branches already described the medial plantar nerve gives twigs of supply, usually from its two medial common digital branches, to the flexor hallucis brevis and the first lumbrical muscle. The medial plantar artery is usually much smaller than the lateral plantar. It accompanies the medial plantar nerve and gives rise to numerous small twigs which for the most part correspond to the branches of the nerve.

The lateral plantar nerve runs forward and laterally across the sole to about the base of the fourth interosseous space, where it ends by dividing into a deep and a superficial branch. From the trunk of the nerve twigs of supply are given to the abductor digiti quinti and the quadratus plantae. Near its beginning the superficial branch supplies twigs to the flexor digiti quinti brevis and the interosseous muscles of the fourth space; its further course has been traced. The deep branch turns medially, deep to the quadratus plantae, where it will be followed later. The lateral plantar artery accompanies the lateral plantar nerve to the base of the fourth

it. Its fibres join a tendon which is inserted into the medial side of the base of the first phalanx of the great toe; as will be seen later this insertion is common to the abductor hallucis and the medial belly of the flexor hallucis brevis. The abductor digiti quinti arises from the lateral process of the tuberosity of the calcaneus. Its fibres extend forward along the lateral side of the sole and join a tendon which is inserted into the lateral side of the base of the first phalanx of the fifth toe; it often exhibits a secondary slip of insertion into the tuberosity at the base of the fifth metatarsal.

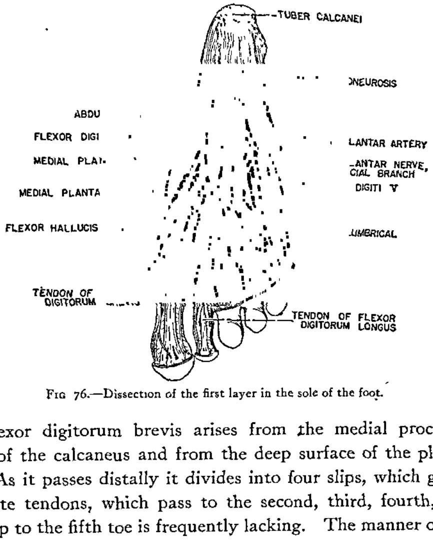

FIG 76.—Dissection of the first layer in the sole of the foot.

The flexor digitorum brevis arises from the medial process of the tuberosity of the calcaneus and from the deep surface of the plantar aponeurosis. As it passes distally it divides into four slips, which give rise to four separate tendons, which pass to the second, third, fourth, and fifth toes; the slip to the fifth toe is frequently lacking. The manner of insertion of these tendons will be examined later; for the present they need be cleaned only as far forward as the heads of the metatarsal bones, where they enter the fibrous sheaths of the flexor tendons.

The medial plantar nerve will be found emerging between the abductor hallucis and the flexor digitorum brevis, and running forward to divide into four cutaneous branches. Of these the most medial passes to the skin on

the medial side of the plantar aspect of the great toe. The remaining three, which are known as common plantar digital nerves, each divide near the heads of the metatarsal bones into two proper plantar digital nerves, which supply the adjacent sides of the first and second, second and third, and third and fourth toes, respectively. The superficial branch of the lateral plantar nerve emerges from under cover of the lateral side of the flexor digitorum brevis and divides into two branches; the more medial of these gives rise to two proper digital branches which supply the adjacent sides of the fourth and fifth toes, and the more lateral supplies the lateral side of the fifth toe.

The second layer of muscles in the sole of the foot includes the tendons of the flexor hallucis longus and the flexor digitorum longus, the quadratus plantae, and the four lumbrical muscles. At this same level will be found the trunks of the medial plantar nerve and artery, crossing deep to the abductor hallucis, and the lateral plantar nerve and artery, which cross deep to both the abductor hallucis and the flexor digitorum brevis. (Fig. 77.)

Divide the abductor hallucis and the flexor digitorum brevis close to their origins and reflect them forward. As this is done, secure the nerves of supply which they receive from the medial plantar nerve. The beginnings of the medial plantar nerve and artery under cover of the lactiniate ligament have already been seen. Their full course may now be traced. In addition to the branches already described the medial plantar nerve gives twigs of supply, usually from its two medial common digital branches, to the flexor hallucis brevis and the first lumbrical muscle. The medial plantar artery is usually much smaller than the lateral plantar. It accompanies the medial plantar nerve and gives rise to numerous small twigs which for the most part correspond to the branches of the nerve.

The lateral plantar nerve runs forward and laterally across the sole to about the base of the fourth interosseous space, where it ends by dividing into a deep and a superficial branch. From the trunk of the nerve twigs of supply are given to the abductor digiti quinti and the quadratus plantae. Near its beginning the superficial branch supplies twigs to the flexor digiti quinti brevis and the interosseous muscles of the fourth space; its further course has been traced. The deep branch turns medially, deep to the quadratus plantae, where it will be followed later. The lateral plantar artery accompanies the lateral plantar nerve to the base of the fourth

interosseous space, at which it turns medially to pass deeply into the foot in company with the deep branch of the nerve. From the part of its course now visible, small twigs are given to the various neighboring muscles.

Trace the tendon of the flexor digitorum longus forward into the sole and observe that it divides into four tendons, which pass into the fibrous sheaths on the plantar aspects of the four lateral toes, where they lie deep to the corresponding tendons of the flexor digitorum brevis. Clean the quadratus plantae. This is a short flat muscle which arises by two heads,

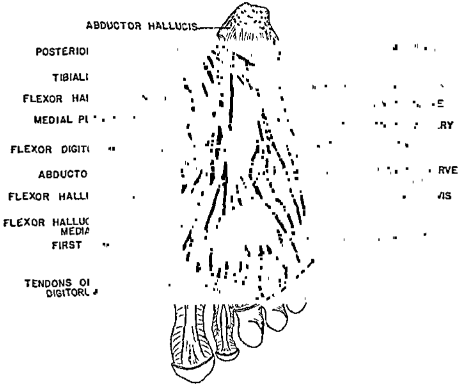

Fig. 77.—The structures of the second layer in the sole of the foot, as exposed by removal of the abductor hallucis and the flexor digitorum brevis

from the lower parts of the lateral and medial surfaces, respectively, of the calcaneus. Its fibres pass forward to be inserted upon the tendon of the flexor digitorum longus. The lateral plantar nerve and artery rest directly on this muscle as they cross the sole. The lumbrical muscles are four small slips, which by their attachments make it possible to extend the interphalangeal joints of the four lateral toes at the same time that the metatarsophalangeal joints are flexed. The first lumbrical arises from the medial side of the first tendon of the flexor digitorum longus; the remaining three each arise from the adjacent sides of two tendons of the flexor longus. Each lumbrical gives rise to a slender tendon which passes around the medial side

of its own digit to join the extensor expansion of that digit on the dorsal side of the proximal phalanx.

Now study the manner of insertion of the flexor tendons into the phalanges. First observe that these tendons are held in place on the plantar aspects of the phalanges by fibrous bands, which, with the plantar surfaces of the phalanges, form an osteo-fibrous canal in each digit, in which the flexor tendons lie. Within each of these canals the tendons of the flexor longus and the flexor brevis are enclosed in a common mucous sheath. Open the fibrous sheath on one or two of the toes to see the insertions of the flexor tendons. Observe that the tendon of the flexor longus perforates the tendon of the flexor brevis and passes forward to be inserted at the base of the terminal phalanx. The flexor brevis tendon is inserted at the base of the second phalanx.

Trace the tendon of the flexor hallucis longus into the foot. Observe that as it enters the sole it rests in a groove on the under surface of the sustenaculum tali, to which it is bound by a strong fibrous band. It then passes forward, crossing deep to the tendon of the flexor digitorum longus, to which it gives a tendinous slip, to enter the fibrous sheath on the plantar aspect of the great toe. It is inserted into the terminal phalanx.

Divide the tendon of the flexor digitorum longus at the point where it enters the foot, detach the quadratus plantae from its origin, and turn the divided portion of the tendon forward, together with the quadratus plantae and the lumbrical muscles. As this is done attempt to find the twigs which the three lateral lumbricals receive from the deep branch of the lateral plantar nerve. Then clean and study the muscles of the third layer. These are the flexor hallucis brevis, the adductor hallucis, and the flexor digiti quinti brevis.

The flexor hallucis brevis arises from the plantar surface of the third cuneiform and the cuboid bone. As its fibres pass forward they become divided into two fleshy bellies which lie on either side of the tendon of the flexor hallucis longus. The medial belly is inserted in common with the abductor hallucis at the medial side of the base of the first phalanx; the lateral belly is inserted in common with the adductor hallucis into the lateral side of the base of the first phalanx. The adductor hallucis arises by two heads, an oblique and a transverse. The oblique head is large and fleshy. It arises from the tuberosity of the cuboid bone and its fibres pass forward

and medially to join the tendon of insertion which is common to the adductor and the lateral belly of the flexor brevis. The transverse head is small and thin. It arises from the capsules of the third, fourth, and fifth metatarsophalangeal joints, its fibres passing medially to join the tendon of insertion. The flexor digiti quinti brevis is a fleshy slip which arises on the base of the fifth metatarsal and runs straight forward to be inserted into the lateral side of the base of the proximal phalanx of the little toe.

The flexor hallucis brevis and the oblique head of the adductor hallucis should now be detached from their origins and turned forward, so that the

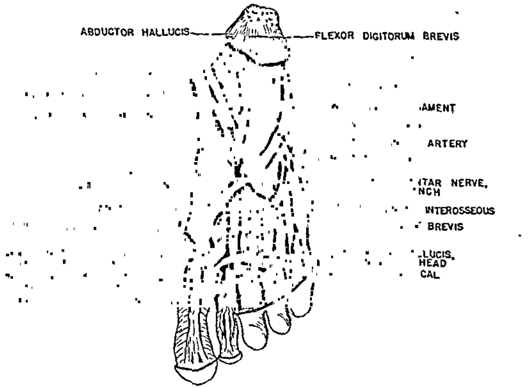

FIG. 78.—The deepest layer of structures in the sole of the foot.

deep plantar arch may be displayed. The deep plantar arch is formed by the medial continuation of the lateral plantar artery, deep to the quadratus plantae and the adductor hallucis, and its junction with the deep plantar branch of the dorsalis pedis artery, which appears in the sole at the base of the first interosseous space. It rests upon the proximal ends of the second, third, and fourth metatarsal bones, and gives rise to four plantar metatarsal arteries. These pass forward in the interosseous spaces, and each divides into two plantar digital arteries, which supply the adjacent sides of two toes. The deep branch of the lateral plantar nerve accompanies the lateral part of the deep plantar arch. This nerve is distributed to the adductor hallucis,

the lateral three lumbrical muscles, and the interosseous muscles of the first, second, and third spaces. (Fig. 78.)

Properly to display the interosseous muscles, it is advisable to remove the transverse head of the adductor hallucis and to cut the transverse ligaments which bind the heads of the adjacent metatarsal bones together. The interossei occupy the interosseous spaces. They are arranged in two groups, consisting of three plantar and four dorsal interosseous muscles. The first, second, and third plantar interosseous muscles arise from the proximal thirds of the medial plantar surfaces of the third, fourth, and fifth metatarsal bones, respectively. Their fibres pass obliquely forward to join three slender tendons which are inserted into the medial sides of the bases of the proximal phalanges of the third, fourth, and fifth toes. One dorsal interosseous muscle is found in each space. Each arises from the adjacent sides of the two metatarsal bones bounding the space in which it lies. The first dorsal interosseous muscle is inserted on the medial side of the base of the first phalanx of the second toe. The second, third, and fourth are inserted on the lateral side of the bases of the first phalanges of the second, third, and fourth toes.

The tendon of the tibialis posterior may now be traced to its insertion. Observe that while its principal attachment is to the tuberosity of the navicular bone, it gives off a secondary slip which spreads over the sole of the foot to gain attachment to the second and third cuneiform, the cuboid and the fourth metatarsal bones. The tendon of the peroneus longus has been traced to the lateral border of the cuboid bone; follow it now across the sole to its insertion on the inferior surface of the first cuneiform and the adjacent part of the first metatarsal. Observe that as it crosses the cuboid bone it is partially ensheathed by the long plantar ligament. This ligament is a strong fibrous band which is attached posteriorly to the entire inferior surface of the calcaneus and passes forward to the tuberosity of the cuboid, from which its fibres spread out to reach the bases of the four lateral metatarsal bones. It is of considerable importance in preserving the longitudinal arch of the foot.

Clean the capsule of the ankle joint. At this joint (articulatio talocruralis) the talus articulates with the inferior extremity and the medial malleolus of the tibia, and the lateral malleolus of the fibula. Its capsule is very thin anteriorly and posteriorly, but is thickened on the lateral and

medial sides. The thickened medial portion is known as the deltoid ligament. It is attached above to the medial malleolus and spreads out inferiorly to be attached, from before backward, to the navicular, the talus, the sustentaculum tali of the calcaneus, and the posterior part of the talus. The thickened lateral portion of the capsule consists of three distinct slips, the anterior talofibular ligament, the calcaneofibular ligament, and the posterior talofibular ligament.

The articulations of the foot include the intertarsal, tarsometatarsal, and intermetatarsal joints, the metatarsophalangeal joints, and the interphalangeal joints. The joints of the first-named groups are worthy of some attention; study of them should be accompanied by constant reference to the mounted skeleton of a foot or to a set of disarticulated bones.

The tarsal and metatarsal bones are arranged in the form of two arches, a longitudinal and a transverse, the concavities of both of which face toward the sole. The longitudinal arch rests posteriorly on the tuberosity of the calcaneus and anteriorly on the metatarsal bones. It is supported principally by the long plantar ligament (Fig. 78) and the plantar calcaneonavicular ligament. (Fig. 79.)

The tarsal and metatarsal bones are connected to one another by dorsal, plantar, and interosseous ligaments. There are six separate articular cavities for the various intertarsal, tarsometatarsal, and intermetatarsal articulations. The talus, through which the entire weight of the body is transmitted to the foot, takes part in two of these: an articulation at which a facet on the body of the talus meets the posterior facet of the calcaneus, and an articulation at which the head of the talus meets the navicular and the sustentaculum tali of the calcaneus. (Fig. 79.)

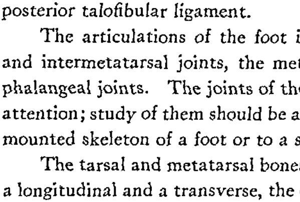

FIG. 79—The tarsal articulations of the talus, opened from above by removal of the talus.

Disarticulate the talus, to open these two articular cavities. Observe that in order to disarticulate the talus, a very strong ligament which fills the tarsal canal (sinus tarsi) must be cut. This is the interosseus talo-calcaneal ligament, which binds the talus and the calcaneus firmly together and separates the two articular cavities in which the talus takes part. Observe

also that the articular surface of the head of the talus is not completely taken up by its articulations with the navicular and the calcaneus, but rests also upon a strong ligament which stretches between the plantar surfaces of the two latter bones. This is the plantar calcaneo-navicular ligament; it rests inferiorly on the tendon of the tibialis posterior.

Of the remaining four articular cavities of the tarsus, one is for the articulation between the calcaneus and the cuboid. A single large articular cavity includes the articulations between the navicular, the three cuneiforms, the cuboid, and the second and third metatarsals. Another cavity includes the articulations between the cuboid and the fourth and fifth metatarsals. The last cavity is for the articulation of the first cuneiform with the first metatarsal. These cavities may be opened and the bones spread apart for observation of the articular surfaces, by cutting through the dorsal ligaments.

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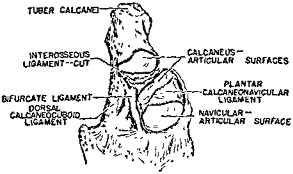

FIG. 79.—The tarsal articulations of the talus, opened from above by removal of the talus.

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